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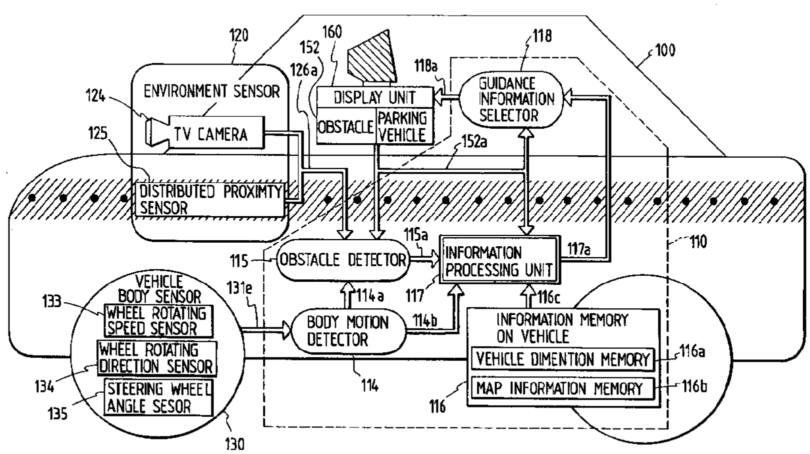
# (54) Vehicle driving support system and vehicle therewith

(57) A vehicle driving support system generating driving reference information by detecting the environmental condition around a vehicle, wherein the vehicle driving support system has an information processor (110, 117) which generates driving reference information suitable for the running condition of said vehicle by processing the environment data obtained by detecting the condition around the vehicle corresponding to the plurality of the running conditions of said vehicle.

FIG. 33

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## Description

### Background of the Invention

#### Field of the Invention

The present invention relates to a vehicle driving support system which provides a driver with reference information for driving a vehicle by means of detecting and processing an environment condition around the vehicle and to a vehicle therewith.

#### Description of the Prior Art

There have been various automatic tracking control systems so far which detect the speed of a preceding vehicle and find the distance between the subject and the preceding vehicles, that is inter-vehicle distance, based on the detected speed, and keep the distance between the two vehicles in order to support long-distance driving in safety.

Such prior art is already disclosed, for example, in Japanese Patent Application Laid-Open No.3-295000 (1991).

There also have been alarm systems which detect the distance between a vehicle and the preceding vehicle and make an alarm sound to caution the driver against a rear-end collision. The alarm systems are described in Japanese Patent Application Laid-Open No.4-201641 (1992) and No.4-201643 (1992).

The prior art mentioned above will be useful when vehicles are continuously running on ordinary roads or highways. From a running mode point of view, however, vehicles are driven more often in a congestion running mode on ordinary streets than in a high speed running mode on driveways. When they are being driven on ordinary streets, they are generally forced to repeat stopping and slow running due to traffic signals and congestions. A driver, therefore, is busy in driving operation when a vehicle is driven in the congestion running mode, and has to keep watching the driving state of the preceding vehicle, as well as watching the state of the street beyond the preceding vehicle. In such a situation, the mental and physical burdens imposed on the driver will be considerable.

Now there are a lot of cases where a driver runs a vehicle in a narrow space such as in a narrow passage in a downtown area, in a narrow parking lot or in a garage. In order to preform such driving reliably, a well experienced and skillful driving technique is indispensable. Especially, for beginners, drivers in name only, and physically handicapped persons, it would be the most difficult item. They have to bear both mental and physical stresses from such driving.

The control system or the alarm system in the prior art described above has no support function for driving operation in such a congestion running mode or a narrow space running mode.

### Summary of the Invention

#### Object

One of the objects of the present invention is to provide a vehicle driving support system which is capable of reducing the driver's burdens in plural kinds of running modes such as congestion running mode, narrow space running mode and the like, and facilitating easy, safe and effective driving for the driver.

Another object of the present invention is to provide a support system which is capable of reducing the driver's burdens to watch forward in a congestion running mode on a congested street, where vehicle is forced to repeat stopping and slow running, by means of monitoring the driving state of the preceding vehicle and informing its change to the driver.

A further object of the present invention is to provide a support system which is capable of easily driving operation in a narrow space running mode, where vehicle is running on a narrow passage, a narrow parking lot or a garage, by means of providing the driver with the information on obstacles existing around the vehicle.

An even further object of the present invention is to provide a support system which is capable of selecting a suitable driving operation reference information corresponding to plural kinds of running conditions of the vehicle and informing it to a driver, and to provide a vehicle therewith.

#### Summary

A vehicle driving support system according to the present invention generates a driving operation reference information suitable to a running condition of a vehicle through processing the environment data obtained from detecting environment condition around a vehicle based on the various kinds of the running conditions of said vehicle and informs it to a driver.

Said vehicle driving support system according to the present invention comprises environment detecting means for detecting objects around the vehicle to output environment data, running condition specify means for selectively specifying the running condition of said vehicle from plural kinds of conditions, information processing means for generating a driving operation reference information suitable to the condition of said vehicle through processing said environment data based on the selected running condition and information means for informing the driving operation reference information to the driver.

More particularly, said running condition specify means comprises input means for specifying the condition of said vehicle, in a normal running condition such as high speed running or in a congestion running condition, by the driver's operation. And when the vehicle is in the congestion condition, said information processing means monitors the distance between said vehicle and

the preceding vehicle and generates driving operation reference information to inform starting of the preceding vehicle to the driver.

Further, said running condition specify means comprises input means for specifying the condition of said vehicle, in a narrow passage running condition or in a parking lot running condition. And when the vehicle is in the narrow passage running condition, said information processing means monitors objects positioning around said vehicle in relationship of relative position and generates driving operation reference information to inform it to the driver. On the other hand, when the vehicle is in the parking lot running condition, the information processing means generates driving operation reference information on distributing condition of the objects existing in said parking lot to inform it to the driver.

Furthermore, said vehicle driving support system comprises a communication unit to obtain more environment information by means of communicating with a ground station or other vehicles.

## Brief Description of the Drawings

FIG.1 is a block diagram showing the basic structure of a vehicle driving support system in accordance with the present invention.

FIG.2 is a flow diagram showing data processing to generate driving operation reference information executed by the information processing unit in FIG.1.

FIG.3 is a block diagram showing the partial structure in one embodiment of a driving support system in accordance with the present invention.

FIG.4 shows a configuration of a command unit and a display unit in the embodiment shown in FIG.3.

FIG. 5 is a flow diagram showing data processing executed by the information processing unit in the embodiment shown in FIG.3.

FIG.6 is a block diagram showing the partial structure in another embodiment of a vehicle driving supporting system in accordance with the present invention.

FIG.7 is a flow diagram showing data processing executed by the information processing unit in the embodiment shown in FIG.6.

FIG.8 is a flow diagram showing detailed data processing in the running reference distance display processing shown in FIG.7.

FIG.9 is a flow diagram showing detailed data processing in the congestion reference distance display processing shown in FIG.7.

FIG.10 shows a displayed picture on the display unit in the running reference distance display processing shown in FIG.8.

FIG.11 shows a displayed picture on the display unit in the congestion reference distance display processing shown in FIG.9.

FIG.12 is a flow diagram showing detailed data processing in the error routine shown in FIG.7.

FIG.13 shows a displayed picture on the display unit in the error routine shown in FIG.12.

FIG.14 shows one embodiment of an information memory format in the memory in the embodiment shown in FIG.6.

Fig.15 is a flow diagram showing data processing in the comparing reference distance information generating processing executed by the information processing unit in the embodiment shown in FIG.6.

FIG.16 is a flow diagram showing detailed data processing in the display information output processing in the comparing reference distance information generating processing shown in FIG.15.

FIG.17 is a flow diagram showing detailed data processing in the comparing reference distance information output processing in the comparing reference distance information generating processing shown in FIG.15.

FIG.18 is a flow diagram showing data processing in a comparing processing executed by the information processing unit in the embodiment shown in FIG.6.

FIG.19 is a flow diagram showing other detailed data processing in the running reference distance display processing shown in FIG.7.

FIG.20 is a flow diagram showing other detailed data processing in the congestion reference distance display processing shown in FIG.7.

FIG.21 is a block diagram showing a further embodiment of the partial structure of a vehicle driving support system in accordance with the present invention.

FIG.22 is a block diagram showing the detailed structure of another embodiment of a distance information detector used in a vehicle driving support system in accordance with the present invention.

FIG.23 is a block diagram showing the detailed structure of a further embodiment of a distance information detector used in a vehicle driving support system in accordance with the present invention.

FIG.24 is a block diagram showing a partial structure of a further embodiment od a vehicle driving support system in accordance with the present invention.

FIG.25 is a graph showing a conversion characteristic of a converter in the vehicle driving support system in accordance with the present invention shown in FIG.24.

FIG.26 is a block diagram showing the structure of an embodiment of a vehicle driving support system suitably applicable to an unmanned vehicle in accordance with the present invention.

FIG.27 shows a desirable configuration of the structural means of a vehicle driving support system in accordance with the present invention mounted on a vehicle.

FIG.28 shows another configuration of a driving support system in accordance with the present invention mounted on a vehicle.

FIG.29 shows a configuration of a command unit and a display unit composing a driving support system

in accordance with the present invention.

FIG.30 shows another configuration of a command unit and a display unit composing a driving support system in accordance with the present invention.

FIG.31 shows a further configuration of a command unit and a display unit composing a driving support system in accordance with the present invention.

FIG.32 is a graph showing another converting characteristic of a converter used in a vehicle driving support system in accordance with the present invention.

FIG.33 is a block diagram showing the partial structure of a further embodiment of a vehicle driving support system in accordance with the present invention.

FIG.34 is a picture showing a detected condition and its result displayed on a display unit obtained by a distributed proximity sensor used as an environment sensor in the embodiment shown in FIG.33.

FIG.35 is a picture showing a condition monitoring environment around a vehicle by using an environment signal from said distributed proximity sensor in the embodiment shown in FIG.33 and a motion data.

FIG.36 is a flow diagram showing data processing for monitoring the environment around a vehicle executed by the information processing unit in the embodiment shown in FIG.33.

FIG.37 is a block diagram showing the partial structure of a further embodiment of a vehicle driving support system in accordance with the present invention.

FIG.38 is a flow diagram showing data processing to generate a guidance information for parking executed by the information processing unit in the embodiment shown in FIG.37.

FIG.39 shows a picture on a display unit displaying parking guidance information.

FIG.40 shows another picture on a display unit displaying parking guidance information.

FIG.41 is a block diagram showing the partial structure of an information memory out of vehicle.

FIG.42 is a picture showing a driver's view during parking with guiding.

FIG.43 a graph showing various running modes of vehicle expressed by a relationship between elapsed time and subject space size.

## Detailed Description of the Preferred Embodiments

Referring to the drawings, some embodiments of the present invention will be explained below focusing on an vehicle.

Firstly, some explanation will be done on the various running modes of the vehicle which drivers encounter with. When a vehicle runs, for example, on a complicated street in downtown, the driver will be forced to make many decisions due to the traffic situation, congestion, etc. According to such traffic information, the driver must decide the proper running mode for route guidance, highway running, general road running, low speed running in a congestion, repetitive stops, lengthwise parking, putting his vehicle into the garage, meeting another vehicle on a narrow passage, avoiding a collision, etc. Basically, those decisions will be made of one's own accord. FIG.43 shows the relationship between elapsed time and object space size in relation to each of those running modes. In order to support the driver for two or more running modes, the close relationship between the driver and the vehicle is indispensable. FIG.43 shows a case in which running modes are changed frequently among highway running, general road running, low speed running in a traffic congestion, and repetitive stop. In fact, those running modes are so important that they must be considered carefully. A driver also frequently encounters narrow passage running mode driving on a narrow passage and parking running mode driving in a parking lot or a garage.

A vehicle driving support system in accordance with the present invention generates driving operation reference information corresponding to such various running modes suitable for their driving operation to provide the driver with it.

FIG.1 is a block diagram showing the basic structure of a vehicle driving support system in accordance with the present invention, and FIG.2 is a flow diagram showing data processing to generate driving operation reference information executed by the information processing unit.

An information processing unit 110 is composed of mainly a micro processing unit which generates an driving operation reference information suitable for a running condition to output on a display unit 160 by means of processing the data, object detecting data around a vehicle obtained from an environment sensor 120, self-vehicle condition detected data obtained from a body sensor 130 and other environment data obtained from communication unit 150, in accordance with the running condition specified by a command signal given from a command unit 150. Said information processing unit 110 also provides a control signal for an output unit 170 which generates alarm sounds or, if necessary, automatically operates a part of a driving operation mechanism of the vehicle.

FIG.2 is a flow diagram showing data processing to generate driving operation reference information executed by said information processing unit, showing normal running, congestion running, narrow passage running and parking running conditions as running modes of the vehicle. The information processing unit 110 analyzes said command signal by means of decision operations 201 ~ 204, in a congestion running condition executing precedent vehicle start monitoring operation 205 to inform the driver of the driving operation reference information that the precedent vehicle stopping ahead starts to running, in a normal running condition executing inter-vehicle distance displaying operation 206 to inform the driver of the driving operation reference information on the suitable distance between the precedent and the subject vehicles, in a

narrow passage running condition executing obstacle monitoring operation 207 to inform the driver of the obstacles existing and approaching the self-vehicle, in a parking running condition executing guidance information displaying operation 208 to inform the driver of the distributing condition of objects in a parking lot.

Referring next to FIG.3 ~ FIG.5, an embodiment of a partial structure of said driving support system will be explained in detail. The function of the structure in this embodiment is to generate driving operation reference information corresponding to a congestion running condition and a normal running condition, and the function thereof is realized by using data processing function of a micro processing unit.

In FIG.3, a distance information detector 121 is shown as a part of the environment detector 120, detecting an object 301 which is a rear part of a vehicle positioning ahead of a self-vehicle, a command unit 151 generating a command signal to specify running conditions being shown as a part of the command input unit 150, a memory 111 and a comparator 112 being shown as a part of the information processing unit 110, an alarm 171 being shown as a part of the output unit 170.

The distance information detector 121 comprises a distance measuring instrument which utilizes ultrasonic wave, laser beam or the like. The command unit 151 is provided near the steering wheel. The unit has push-buttons which are used by a driver to select and input each of the running modes. The push-buttons include, as shown in FIG. 4, a button for congestion 151a and a button for normal running 151b.

The memory 111 of a part of the information processing unit 110 is used to store the reference distance information corresponding to each of the running modes output from said command unit. When the running mode is the congestion running, the reference distance information is a detected inter-vehicle distance data obtained from the distance information detector 121 at the time the command signal is input. And when the running mode is the normal running mode, the reference distance information is a detected inter-vehicle distance data obtained from the distance information detector 121 at that time or an inter-vehicle distance to be kept for safe driving. Said comparator 112 compares the detected inter-vehicle distance output from said distance information detector 121 with the reference distance information output from said memory 111, and outputs the result. Said display unit 160 displays the labeling character message of the running mode directed from said command unit 151 and the reference distance information output from said memory 111 corresponding to this running mode.This display unit 160, as shown in FIG.4, is provided beside the push-buttons 151a and 151b of the command unit 151 near the steering wheel. The unit has a display window 160a for the congestion or running message and the reference distances. The display unit 160 may comprise a head-up display so that data can be displayed on the wind shield.

Said alarm 171 generates alarm sounds based on the result of the comparison output from said comparator 112.

Referring next to FIG.5, the operation of the embodiment described above will be explained. In this embodiment, driving is supported according to the traffic condition. In process 301, the information processing unit 110 monitors the command signal sent from the command unit 151. For example, with pushing the congestion push-button 151a of the command unit 151 while the subject vehicle stops on a congested road, the command signal is generated and the processing moves to process 302. In process 302, with corresponding to the command signal generated by means of pushing the congestion push-button 151a, the detected inter-vehicle distance data output from the distance information sensor 121 is read and stored in the memory 111. The process 302 is executed only when the push-button is pushed and the command signal is generated. The processing, next, moves to process 303 and said reference distance information is output to the display unit 160. The display unit 160 displays the labeling message of running mode and the reference distance information corresponding to the command signal output from the command unit 151.

In process 304, the detected inter-vehicle distance data detected with the distance information detector 121 is periodically road and led to the comparator 112. In process 305, the inter-vehicle distance is compared with the reference distance information output from the memory 111.

When the detected inter-vehicle distance data exceeds the reference distance, the processing moves to process 306 and the alarm 171 receives a control signal and generates alarm sounds to indicate the vehicle in front starting to move.

Thus, only pushing the congestion push-button 151a during the condition of stopping his vehicle due to congestion, the driver can take a rest, looking at a map, giving his eyes a rest and so on until the alarm is generated indicating that the vehicle in front has begun to move. The driver can reduce his mental and physical burdens considerably in such ways.

On the other hand, when the running push-button 151b of the command unit 151 is pushed during normal running to generate a command signal, the inter-vehicle distance data for safe driving is read out as a reference distance information from the memory 111 and led to the comparator 112, then the data is compared with the detected inter-vehicle distance data output from the distance information sensor 121 and the result is output to the alarm 171. By providing an apparatus for operating an accelerator and a brake as to keep the inter-vehicle distance equal to the value of the reference distance information instead of the alarm 171, an automatic tracking running control to keep a safety inter-vehicle distance against a precedent vehicle can be realized. The standard value of the safety inter-vehicle distance

for the automatic tracking can be determined based on the actual detected inter-vehicle distant data output from the distance information sensor 121 when the running push-button 151b is pushed. Further, it is preferable that said reference distance information during the automatic tracking running control operation changes depending on running speed.

FIG.6 shows another embodiment of the partial structure of a vehicle driving support system in accordance with the present invention. In this figure, the same item numbers are used for the components having the same functions in the embodiment shown in FIG.3. In this embodiment, a selector 113 is included in the information processing unit 110. The comparator 112 is different from that in FIG.3 only to the extent that the comparator in this embodiment has a function to output the inter-vehicle distance information from the distance information detector 121 to the memory 111, and the reference distance information to the comparator 112 is entered from the selector 113, and further the display unit 161 displays data from both the distance information detector 121 and the selector 113.

Referring to FIG.7, the operation of another embodiment of the present invention described above will be explained.

In this embodiment, the information processing unit 110 analyzes the command signal from the command unit 151 to form the driving information suitable for the normal running condition or the congestion condition. When an improper signal is output from the command unit 151, it is processed as an error. In a case where the command unit 151 used is of a type of having the push-buttons 151a and 151b as shown in FIG. 4, the analysis on the command signal is carried out through discriminating the command signal generated by means of pushing the "congestion" or the "running" push-button. These buttons may be physical ones or dummy ones materialized using a graphic display and a touch panel.

In process 310, a command signal is monitored to come and the processing moves to process 320 when the signal is received. In process 320, an analysis is carried out on whether or not said command signal is generated by means of pushing the running push-button 151b. In a case where the command signal is generated by means of pushing the push-button 151b, the processing moves to process 330 and the running reference distance display process is executed.

The running reference distance display process 330 in this embodiment has such steps, as shown in FIG.8, that in process 331 the character string " running" is stored in the condition memory area of the memory 111 as a labeling display message, in process 332 the detected inter-vehicle distance data received by the comparator 112 output from the distance information sensor 121 is stored in the running reference information memory area of the memory 111 as a reference distance information, and in process 333 both of the information are displayed on the display unit 160. An example of the displayed picture is shown in FIG.10.

When the command signal is not generated by means of pushing the push-button 151b, the processing moves to process 340. In said process 340, an analysis is carried out on whether or not the command signal is generated by means of pushing the congestion push-button 151a. In a case where the command signal is generated by means of pushing the congestion push-button 151a, the processing moves to process 350 and the congestion reference distance display process is executed.

The congestion reference distance display process 350 has such steps, as shown in FIG.9, that in process 351 the character string "congestion" is stored in the condition memory area of the memory 111 as a labeling display message, in process 352 the detected inter-vehicle distance data received by the comparator 112 from the distance information sensor 121 is stored in the congestion reference information memory area of the memory 111 as a reference distance information, and in process 353 both of the information are displayed on the display unit 160. An example of the displayed picture is shown in FIG.11.

When the command signal is generated by means of neither of the push-button 151a nor 151b, the processing moves to the error routine 360. The error routine 360 has such steps, as shown in FIG.12, that in process 361 the character string " error" is stored in the condition memory area of the memory 111 as a labeling display message, and in process 362 the information is displayed on the display unit 160. An example of the displayed picture is shown in FIG.13.

FIG.14 shows an example of the stored data format within the memory 111 in the embodiment shown in FIG.6. In the memory 111, the running reference distance, the congestion reference distance, the vehicle speed, the distance information detector 121 output are stored corresponding to their names. The vehicle speed data, therein, is entered to the memory 111 by means of branching off the signal transferred to an ordinary speed meter. The selector 113 generates the display information to be transferred to the display unit 160 and the comparing reference distance information to be transferred to the comparator 112 based on the stored data within the memory 111 shown in FIG.14.

The comparator 113, as shown in FIG.15, executes data read out process 370 to read out data from the memory 111, display information output process 380 and comparing reference distance information output process 390 to output the display information and the reference distance information.

The display information output process 380 has such steps, as shown in FIG.16, that in process 381 an analysis is carried out on whether or not the command signal is generated by means of pushing the running push-button 151b, in a case where the command signal is generated by means of pushing the running push-button 151b the display information output process 382 is

executed. And in a case where the command signal is not generated by means of pushing the running push-button 151b, in process 383 an analysis is carried out on whether or not said command signal is generated by means of pushing the congestion push-button 151a, and the display information output processing 384 is executed in a case where the command signal is generated by means of pushing the congestion push-button 151a. In a case where the command signal is generated by means of pushing neither of the push-button 151a nor 151b, the display information output process 385 is executed.

The comparing reference information output process 390 has such steps, as shown in FIG.17, that in process 391 an analysis is carried out on whether or not the command signal is generated by means of pushing the running push-button 151b, in a case where the command signal is generated by means of pushing the running push-button 151b the comparing reference distance information output process 392 is executed. And in a case where the command signal is not generated by means of pushing the running push-button 151b, in process 393 an analysis is carried out on whether or not said command signal is generated by means of pushing the congestion push-button 151a. In a case where the command signal is generated by means of pushing the congestion push-button 151a, the comparing reference distance information output process 394 is executed. In a case where the command signal is generated by means of pushing neither of the push-button 151a nor 151b, process 395 is executed to output the character string "comparison impossible" as a comparing reference distance information.

The comparator 112 in this embodiment executes the comparing process shown in FIG.18. Firstly, in process 401 the comparing reference distance information output from the selector 113 is read out, and then in process 402 an analysis is carried out on whether or not the information is a characteristic string "comparison impossible". In a case where the information is not the characteristic string "comparison impossible", the processing moves to process 403 and said comparing reference distance information is input to comparison calculating process. Next, in process 404 measure comparing calculation processing is executed between the detected inter-vehicle distance data and said comparing reference distance information, and the result is output to the alarm 171.

The running reference distance information process 330 described above can be modified as shown in FIG.19. The modification has checking function whether or not any erroneous operation exists in the driver's button pushing action by referring with a running speed information, and the error routine is executed when the error exists. That is, the modification has a process 335 for reading in vehicle speed data from the memory 111, a process 336 for analyzing whether or not said vehicle speed is equal to zero and an error routine 337 being executed when the vehicle speed is zero.

Further, the congestion reference distance information process 350 described above can be modified as shown in FIG.20. The modification also has checking function whether or not any erroneous operation exists in the driver's button pushing action by referring with a running speed information, and the error routine is executed when the error exists. That is, the modification has a process 355 for reading in vehicle speed data from the memory 111, a process 356 for analyzing whether or not said vehicle speed is equal to zero and an error routine 357 being executed when the vehicle speed is zero.

Both of the modifications have advantages in storing and displaying the reference distance with checking the compatibility between the driver's button pushing action and the actual running condition.

FIG.21 shows one more embodiment of this invention, in which a resetter is added to the embodiment shown in Figure 3 for more practical configuration. In Figure 21, the same item numbers in Figure 3 are used for the member having the same function. The resetter 152, a part of the command input unit 150, generates a resetting signal with referring to a command signal 131a actuated by the driver's button pushing action or accelerator pushing action or the signal generated by the output unit or alarm 171. The resetting signal stops the operation of an information processor 110 and, if necessary, a distance information detector 121. the resetter 152 generates the resetting signal instantaneously in reaction with the command signal generated by the push-button or the accelerator-pushing, and, on the other hand, generates the resetting signal after a certain period in reaction with the signal generated by the alarm.

It is convenient that the reset button is provided near the steering wheel as well as the push-buttons described above.

FIG.22 shows another concrete structure of the distance information detector 121 used in the present invention. In this embodiment, the ultrasonic wave signal 121b from the transmitter 121a is beamed to the object 301. The reflection signal 121d is received by the receiver 121c. At this time, the timer circuit 121f is started with the signal 121e synchronized with the radiation of the ultrasonic wave signal 121b and stopped with the signal 121g synchronized with the reflection signal 121d. With this, the ultrasonic wave round-trip time is measured with the timer circuit 121f. This measured time is transferred to the memory circuit 121h to store and converted to a distance signal in the distance converter 121j. In this case, usually, the distance converter 121j may be a converter having a coefficient multiplier formed with the relationship between the propagation time of ultrasonic wave and the propagation distance, and output a detected inter-vehicle distance data 121k which is the propagation distance having the propagation time of one-half of the measured

time.

Instead of the ultrasonic wave, a modulated optical signal may be used. In this case, the timer circuit 121f can be used as a phase detector to detect the phase difference between emission light and received light.

FIG.23 shows another modified structure of the distance information detector 121 used in the present invention. In this embodiment, the ON-OFF signal generated by an ON-OFF controller 121m is used to control a laser beam 121b emitted from a laser emitter 121a. When the laser beam is ON, that is, when the spot laser beam is emitted on part of the object 301, the object 301 image is picked up by a camera unit 121p from another angle of the laser emitted direction through a mirror 121n. The image signal 121q from the camera unit 121p is stored in a temporary memory 121r. When the laser beam is OFF, that is, when the spot laser beam is not emitted, the object 301 is picked up by the camera unit 121p in the same way, and the image signal 121q is subtracted from the image signal 121s stored in the temporary memory 121r in a subtracter 121t. With this, the complicated patterns peculiar to the object 301 offset each other. As a result, the difference signal 121u output from the subtracter 121t is assumed as an ideal signal which is brighter only in the portion corresponding to the small spot laser beam. In general, however, the signal noise level is weak and difficult to be identified. This is why the laser beam is turned ON/OFF repetitively, and the difference signal 121u of the image signal 121q obtained at the current ON/OFF cycle is added to the difference signal 121x integrated at the past ON/OFF cycle in a cumulative memory 121w by means of an adder 121v and then the result is re-stored into the cumulative memory 121w. The final difference signal stored in the cumulative memory 121w after it is turned ON/OFF repetitively according to the specified number of times offsets noises and is assumed as an image signal of a brighter spot laser beam. This image signal is read, and its threshold value is processed in the position detector 121y, and the position corresponding to the spot laser beam in the image signal is detected therefore, then the value is assumed as the distance between the laser emitter 121a (distance information detector 121) and the object 301. Actually, since the direction of the laser beam emission differs from the direction of image picking-up, the position in the image signal is non-linear with the actual distance. Thus, the value may be converted in the distance converter 121z as needed. The output 121k is the detected inter-vehicle distance data. This kind of distance information detector is described more in detail in Japanese Patent Application Laid-Open No.61-37563 (1986).

FIG.24 shows the partial structure of a further embodiment of the vehicle driving support system in accordance with in the present invention. In this figure, the same item numbers are used in FIG.1 for the structural members having the same function. This embodiment shows an actual structure in which the relative positioning relation from the vehicle in front (inter-vehicle distance) is kept at the required value during normal running in order to make it possible for the subject vehicle to follow up the preceding one. To drive an vehicle in such way is especially effective during driving on a highway, preventing the driver's fatigue for safety. When the driver attempts to follow up the vehicle in front, the inter-vehicle distance information to the subject precedent vehicle 301 is, as the aforementioned embodiments, read out from the distance information detector 121 and stored into the memory 111 in the information processor 110 in accordance with the command signal given from the command unit 151 such as a start button. In this case, the distance information detector 121 can detect the inter-vehicle distance and output distance continuously or cyclically until the resetter 152 is actuated with the signal from the command unit 151. This can also be realized using the said distance information detector 121 shown in FIG's 22 and 23 when the detector 121 is started repetitively with the signal from the information processor 110. The detected inter-vehicle distance information measured and updated continuously is compared with the reference distance information preset and stored in the memory 111 in the comparator 112. Then, the difference between the detected signal and the set value is output to the control unit 172. In the control unit 172, the accelerator operating signal 172a and the brake operating signal 172b are output and used to automatically control the manipulated variable for the accelerating means or the braking means according to the difference signal of positive or negative value. These signals allow an automatic tracking driving to keep the inter-vehicle distance from the preceding vehicle at a constant value.

To reset such automatic tracking driving mode, it is only needed to step on the accelerator or the brake operated automatically. The resetter 152 is then actuated with the command signal 131a generated by stepping on the accelerator/brake and the operation resetting signal is transferred to the information processor 110.

When the subject vehicle comes to a curve during tracking driving, images from a camera unit such as a TV camera provided optionally are used to find the condition of the curve through image processing, for example, through analyzing the boundary or center line of the driving lane in order to control the target direction of the distance information detector 121 to be able to follow up the preceding vehicle. The position of the preceding vehicle within its image can be recognized through image processing and the target of the distance information detector 121 can be controlled in that direction. In the Figure, a simpler method is shown. In this method, the self-vehicle steering wheel angle signal 131b detectable by a simple angle detector is used to drive the angle controller 122 and control the target direction of the distance information detector 121 provided in the controller 122 in order to hold the direction

of the preceding vehicle approximately. In this case, normal driving is assured even when the distance information detector fails in catching the preceding vehicle in the target direction and the detected distance information data measured is changed abruptly. And the controller 172 generates alarm sounds to call a driver's attention and controls to keep the speed at a fixed value for a while until the preceding vehicle is caught. Such processing can be realized easily, for example, with the information processor 110 comprising a microprocessor.

In a case where a vehicle running in front increases or decreases its speed, the vehicle has to be followed up at a proper inter-vehicle distance corresponding to that speed. In such a case, it is only needed to find the proper reference inter-vehicle distance is decided by the subject vehicle speed signal 131c using the converter 132 to update the data in the memory 111. The converter 132 input/output is made as shown with the curve C in FIG.25. It can be realized easily using, for example, a microprocessor and a memory circuit, which are combined into a function generator to generate a function that passes the point A in the Figure indicating the set speed v and the inter-vehicle distance d at that time and the point B indicating the desired inter-vehicle distance b when the speed is 0, that is, when the vehicle stops. To realize this function with the simplest straight line, the relationship between the inter-vehicle distance D and the speed V will be expressed as the following equation.

$$D = (d - b) / v \times V + b \qquad \text{(Equation 1)}$$

Thus, it is only needed that the converter 122 is an arithmetic unit to calculate the proper inter-vehicle distance D corresponding to the speed V based on this equation. In this case, when the inter-vehicle distance b at the zero-speed is 5m, then the inter-vehicle distance can be secured properly and the subject vehicle can stop with a final inter-vehicle distance of 5m when the vehicle in front decreases its speed and stops.

When the driver commands a tracking driving during running at a speed of v and the inter-vehicle distance d from a vehicle in front is excessively smaller than the speed v, then the tracking driving is dangerous. In other words, it may be dangerous when the function that passes the point A (v, d) shown in FIG.25. In such a case, a standard function $C_o$ can also be used together to shift over into a tracking driving with keeping a safe distance. In other words, the values d and $d_o$ (see FIG.25) of both the function C and the function $C_o$ output from the converter 132 are transferred to the information processor 110. Then, the preset inter-vehicle distance value d in the memory 111, which is initially set based on the output value of the function C at is updated to the distance $d_o$ based on the function $C_o$ gradually at certain inter-vehicle distances through intermediate values between C and $C_o$, and finally converted to the set inter-vehicle distance value $d_o$ of the function $C_o$. The processing like this can be executed easily by the information processor 110 comprising a microprocessor. Thus, the subject vehicle is separated by a safe inter- vehicle distance from the preceding vehicle, and finally the subject vehicle can go into the tracking driving keeping the safe inter-vehicle distance.

On the other hand, the vehicle driving support system in accordance with the present invention can be applied even to the vehicle that runs on a specific railway with no modification or with slight modifications. In this case, the vehicle may be a manned railway vehicle, an unmanned railway vehicle, and an unmanned auto carrier (robot) that runs in factory premises. FIG.26 shows the structure of an embodiment in accordance with the present invention, which can be applied to such unmanned driving of vehicles.

In this embodiment, the distance information detector 121 may be an indirect distance measuring instrument such as a distance calculator used to measure the distance between the subject and preceding vehicles according to the position signals of both the subject and preceding vehicles to be transferred via the operation control center of the subject railway or unmanned carrier system. The distance between both the vehicles is not measured directly at this time. The reference distance information is not obtained through a process in which with the driver's start command the distance information from the distance information detector 121 is not input into the memory 111, but the reference distance information is obtained through approaches in which with the command from the command unit 151 the distance information is sent from the operation control center and stored into the memory 111 as a fixed reference distance information or at the start of the system operation a fixed distance information is directly set in the memory 111 from the command unit 151. Especially, in a case of an unmanned vehicle, it would be convenient to use the preset fixed distance information. The inter-vehicle distance from the preceding vehicle, which is measured directly or calculated indirectly, is updated with time and compared with the preset reference distance information in the memory 111 by the comparator 112, and the differential signal is output to the controller 172. The controller 172 outputs the accelerator operation signal, that is, the accelerating signal 172a and the brake operation signal, that is, the speed reduction signal 172b according to the condition the differential signal is positive or negative. When the inter-vehicle distance from the vehicle in front is decreased, the subject vehicle speed is also decreased. The reference inter-vehicle distance information preset in the memory 111 is automatically updated to be decreased by the converter 132 corresponding to the speed reduction according to the function as shown in FIG.25. As a result, the speed reduction in this case is made not abruptly but smoothly. When the preceding vehicle stops at this time, the subject vehicle also stops at the required stop interval b. When the vehicle in front begins

to move, the interval is also increased. Thus, the subject vehicle begins to follow up the precedent vehicle. As the inter-vehicle distance with the precedent vehicle is increased, the subject vehicle is accelerated. In such way, as the vehicle speed is increased, the set value in the memory 111 is increased according to the signal from the converter 132. The tracking driving is thus made at a specific inter-vehicle distance longer than that when the subject vehicle stops.

FIG.27 shows the desirable configuration of an embodiment of the structural means mounting a vehicle driving support system in accordance with the present invention onto a vehicle. In this embodiment, the distance information detector 121 is provided on the front of the subject vehicle. The display unit 160, the command unit 151, and the output unit 170 are provided near the driver seat. Therewith, the commanding operation is easily carried out and alarms can be surely informed to the driver.

FIG.28 shows anther embodiment of a vehicle driving support system in accordance with the present invention mounting onto a vehicle. In this embodiment, the output unit 170 is provided near the vehicle controller (not shown). This allows simplifying the structure for an automatic driving control.

FIG.29 shows a further embodiment of a vehicle driving support system in accordance with the present invention mounting onto a vehicle. In this embodiment, the command unit 151 and the display unit 160 are formed as a head-up display with touch-panel to display the images on the windshield.

FIG.30 and FIG.31 show other embodiments of the command unit 151 and the display unit 160 in accordance with the present invention mounting onto a vehicle. In FIG.30, the command unit 151 and the display unit 160 are provided on the dashboard. In FIG.31, the command unit 151 is provided on the dashboard and the display unit 160 is provided as a head-up display.

On the other hand, the vehicle driving support system in accordance with the present invention can also be used for the rendezvous of moving bodies such as artificial satellites. In other words, when a satellite draws near the preceding satellite to be linked, the curve $C_1$ or a straight line that passes the origin 0 as shown in FIG.20 is used instead of the input characteristic C of the converter 132 shown in FIG.25. In this case, as the speed is decreased, the interval between those satellites is set smaller, getting close to 0 gradually. This makes the rendezvous possible with no shock.

The vehicle driving support system in accordance with the present invention can also be used for a flying body like a missile. To use the vehicle driving support system in order to hit the target at a required speed, the curve $C_2$ or a straight line that passes the horizontal axis at the point P as shown in FIG.32 may be used. At this time, when the distance to the target becomes 0, the speed, that is, the speed at the point P reaches the required speed of collision.

Since according to the present invention vehicles can be allocated on a road or railway more than in the conventional method, a high density and high efficiency driving control can be realized. For this purpose, a more useful system may be structured especially for a railway in an overcrowded city as a loop railway system.

As explained above, the vehicle driving support system can monitor the restarting of the preceding vehicle during stopping of the vehicle, which would ease the tension of the driver in traffic congestion. During running, the driver can follow up the precedent vehicle with keeping a proper distance from the precedent vehicle, which would assure the driver of safe driving, especially driving on a highway. Thus, the driver can be freed extensively from the mental and physical burdens to be imposed during driving, allowing safe driving to be made.

FIG.33 shows the partial structure of a further embodiment of the vehicle driving system in accordance with the present invention. In the figure, the numeral 100 indicates an vehicle in which the vehicle driving support system in accordance with the present invention is mounted.

Said support system 110 comprises a body motion detector 114, an obstacle detector 115, an information memory on vehicle 116, an environmental information processing unit 117 and a guidance information selector 118, which are comprised in a micro processing unit. An environment sensor 120 has a TV camera 124 and a distributed proximity sensor 125. A vehicle body sensor 130 has a wheel rotating speed sensor 133, a wheel rotating direction sensor 134 and a steering wheel angle sensor 135. A command unit 152 is provided as a command input unit having a push-button to request the information on obstacles around the vehicle and a push-button to request the information on guidance information in a parking lot.

The body motion detector 114 generates motion data 114a and 114b based on a motion signal 131e from the vehicle body sensor 130.

The obstacle detector 115 generates obstacle data 115a based on the environment data 126a from the environment sensor 120 and the motion data 114a from the body motion detector 114. The information memory on vehicle 116 has a vehicle dimension memory 116a and a map information memory 116b.

The environment information processing unit 117 generates various environment information 117a around the vehicle by calculating with using the motion data 114b from the vehicle body sensor 114, the obstacle data 115a from the obstacle detector 115 and the memory data 116c from the information memory on vehicle 116 based on the command signal 152a from the command unit 152. And the guidance information selector 118 supplies a suitable guidance information 118a to the display unit 160 by selecting the environment information 117a generated by the information processing unit 117 corresponding to the command sig-

nal 152a.

Next, each of components composes the support system described above will be explained in detail.

The body motion detector 114 receives the motion signal 131e from the wheel rotating speed detector 133, the wheel rotating direction detector 134 and the steering wheel angle detector 135, obtains the running direction and the running speed of the vehicle using the motion signal 131e, then outputs the result as the motion data 114a and 114b.

The obstacle detector 115 obtains the locations and the surface shapes of the obstacles around the vehicle using the TV camera 124 and/or the distributed proximity sensor 125 and the motion data 114a from the body motion detector 114 and outputs the result as the obstacle data 16.

The environment information processing unit 117 obtains memory data 116c from the vehicle dimensions memory 116a and the map information memory 116b, motion data 114b from the body motion detector 114, and obstacle data 115a from the obstacle detector 115, and mixes them to calculate for finding and outputting the environment information 117 around the vehicle in the real time corresponding to the real dimensions of the vehicle.

The guidance information selector 118 then selects the most proper guidance information 118a for the driver from the viewpoint of safety, allowance, etc. according to the criteria that whether or not it is possible for the driver to judge the information subjectively. The selected result is output onto the display unit 160 such as instrument panel, console panel and so on.

Although not shown in the Figure, the guidance information may be used to drive informing means that transmits information to other human senses than the visual sense, for example, a device that issues alarms and shakes the driver seat to indicate something important as well as image display.

Although not shown in the Figure, the guidance information system may be used to avoid an accident when a collision might occur by means of converting the information into a signal to control the brake and/or the steering wheel in a case where the ambient condition is judged dangerous.

According to this embodiment, as mentioned above, the present invention can provide a vehicle driving support system which can act for doing the comparatively low level "data processing" work in the driver's "information generation works" (= interpretation of the environmental conditions).

FIG.34 is a view showing the detecting condition and the result displayed on the display unit 160 which a distributed proximity sensor 125 is used as the environment sensor 120. The distributed proximity sensor 125 may be, for example, a combination of an LED (near infrared ray diode) and PD (photo-diode) which is equipped on the periphery of a vehicle 100 in a belt-shape. The environment signal 126a from the distributed proximity sensor 125 is used to get the shape information of the target obstacles detected near the subject vehicle. The information is output onto the display unit 160 as a bird's-eye view map that includes the vehicle itself.

The result detected by the distributed proximity sensor 125 is displayed as shown in the figure where when no obstacle is detected a white circle 125a is displayed, and when an obstacle is detected a black circle 125b is displayed. A black triangle 100a indicates the forward direction 100b of the vehicle. When data is displayed on the display unit 160, the driver can recognize an obstacle X existing in the rear left and its shape.

FIG.35 shows how the environment conditions are monitored using the environment signal 126a from the distributed proximity sensor 125 and the motion data 114a. Referring to FIG.36, the processing flow for monitoring the environment conditions will be explained.

In process 501, the environment signal 126a indicating the obstacles detected around the vehicle is obtained from the distributed proximity sensor 125, then in process 502 the signal is stored in the memory as an environment signal 126b.

In process 503, the body motion detector 114 obtains the vehicle motion data 131e from the signals output from the wheel rotating speed detector 133, the wheel rotating direction detector 134 and the steering wheel angle detector 135, and then outputs motion data 114a and 114b.

In process 504, the obstacle detector 115 temporarily set the vehicle's running direction as the target area referring to the environment signal 126b and the motion data 114a. And in process 505, it is judged whether or not obstacles exist in the target area. when no obstacle is detected, the area is decided as the target area in process 506. When an obstacle exists, in process 507 the direction towards the obstacle is further checked to decide whether or not it can be selected as the target area. The accuracy of the distributed proximity sensor 125 is raised such way only in the necessary area, reducing the influence by noises effectively. In next process 508, the obstacle detector 115 decides the judgment level for the detection area 125c and the discrimination of obstacle existing. In process 509, the obstacle detector 115 obtains the environment signal 126a from the distributed proximity sensor 125. In next process 510, the environment signal 126b stored beforehand is subtracted from this environment signal 126a to obtain more accurate obstacle data 115a.

In process 511, the environment information processing unit 117 obtains the stored data on the vehicle dimensions 116c from the vehicle dimensions memory 116a, the motion data 114b from the body motion detector 114 and the obstacle data 115a from the obstacle detector 115 to generate a shape information on the vehicle itself and the obstacle X detected near the vehicle and the environment information 117a corresponding to the vehicle motion by means of calculating with

these information.

After this, in process 512, in accordance with the command signal 152a from the command unit 152 the guidance information selector 118 generates the guidance information 118a which has a bird's eye view map including the vehicle overlapped on other information and displays it on the display unit 161, providing accurate guidance information of the obstacle X at a proper timing.

In process 513, the obstacle detector 115, the environment information processor 117 and the guidance information selector 118 then judge whether or not the processing needs to continue referring to the command signal 152a. When judged necessary to continue, the processing returns to process 502 to store the environment signal 126a as the environment signal 126b.

FIG.37 shows the partial structure of a further embodiment of the vehicle driving support system in accordance with the present invention. The support system is a system formed by adding a communication unit 140 to the embodiment described with referring to FIG.33 ~ FIG.36. The system can obtain wide ranged information such as map information, congestion information, route direction, information from other vehicles and so on in the real time from an information memory out of vehicle 141 through road-vehicle, vehicle-vehicle or satellite communications for an infrastructure or the like. The communication unit 140 communicates with the information memory out of vehicle 141 while the communication unit transferring the communication data 140a with the environment information processor 117.

FIG.38 shows the processing flow to generate the guidance information for parking using the support system shown in FIG.37. FIG.39 and FIG.40 show examples of the bird's eye view map for the parking guidance. This processing flow is basically the same as that of the obstacle detection shown in FIG.36. Referring to FIG.38, the processing will be explained more in detail. The environment information detected only around the subject vehicle in process 701 corresponds to the processes 501 through 511 as shown in FIG.36.

Then, in process 702, the environment information processor 117 obtains the information from the distributed proximity sensor 125 mounted on another vehicle through the communication unit 140 as communication data 140a. In process 703, the information is mixed and calculated in said environment information processing unit 117 to obtain the wide ranged environment information 117b including the obstacle that might interfere with the vehicle motion.

As for the vehicle that is moving or might be about to move, the moving direction is displayed as a vector. The length of the arrow mark indicates the moving speed and the type of the arrow mark indicates the level of danger. Explaining more in detail, there are the following types of arrow marks. Black arrow mark A, square mark with hollow arrow B, and circle mark with hollow arrow C. The safety goes lower in order of A, B, and C. In other words, C has the highest possibility of collision or scraping. Concretely, the black arrow mark A indicates that no obstacle exists in the moving direction. The square mark with hollow arrow B indicates that the vehicle is coming toward the obstacle. The circle mark with hollow arrow C indicates that the obstacle (another vehicle ahead, which is regarded as an obstacle) is also coming toward the self-vehicle (approaching).

As a result, the guidance information selector 118 calculates for whether or not an obstacle exists near the self-vehicle in process 704. When no obstacle exists, in process 706 the system selects the arrow mark A. When an obstacle exists, in process 705 the system further calculates for whether or not the obstacle is coming towards the self-vehicle. If not, the system selects the arrow mark B in process 707. If the obstacle is coming, the system selects the arrow mark C in process 708. Then in process 709, the system sets the direction and length of the arrow mark according to the moving direction and speed of each obstacle and decides the conditions of the arrow mark to display. The guidance information selector in process 710 generates the wide ranged guidance information 118a and in process 711 the display unit 160 displays the result.

After this, in process 712, the obstacle detector 115, the environment information processor 117 and the guidance information selector 118 judge whether to continue the processing again with referring to the command signal 152a. If judged necessary, the processing returns to process 701.

The driver can know the condition of the whole necessary space, for example, with the wide ranged guidance information 118 displayed as shown in FIG.39. Thus, the driver can select the most proper parking area for him. In addition to the presence or absence of obstacles, the driver can also obtain the information on the level of danger and the direction in which the obstacle is detected.

The driver can also use the information around the parking lot P, such as house H, tennis court T and the like to select an action to be taken freely and efficiently after he leaves his vehicle.

As for a vehicle that faces in an oblique direction, in FIG.39 the direction into which the vehicle is moving or is about to move actually is displayed as a block D. In FIG.40, however, the vehicle is regarded as a block E which is sectioned with partial lines both perpendicular and parallel to the vehicle in top plan view. The vector of the moving direction is divided into vectors of the X and Y directions. Each vector is then displayed as an arrow mark corresponding to the level of danger in each direction. These two displaying methods can be selected to suit the optimized parking guidance. For example, it will be as shown in FIG.39 when the current parking condition has to be known as early as possible, and will be as shown in FIG.40 when the allocation of vehicles has to be considered or the level of danger has to be found.

FIG.41 shows a part of the information memory out of vehicle 141. An image information displayed on the display unit 142 in said information memory out of vehicle used by the parking manager is shown in the figure. FIG.42 shows the visual field of the driver during the parking guidance operation. As the manager gives direction information to go into the parking area to the vehicle 100 using a mouse 143, said information is transferred to the environment information processor 177 through the communication unit 140 and displayed onto the display unit 161. The driver can be led to the parking area much more efficiently both in space and time than in a case where he will rely only on the information given from the manager directly through the windshield. In addition, another method to support the parking of the vehicle 100 can also be considered. In this case, the driver is not needed to lead his vehicle to the parking area. The driver and/or the manager gives the directions to allocate a parking area to the vehicle 100. The guidance information is transmitted to the vehicle according to the directions.

As explained above, the present invention can provide the driver with an optimized information depending upon the various running condition by means of constructing an integrated support system by selectively combining the parts in the embodiments described above.

**Claims**

1. A vehicle driving support system comprising:

   environment sensors (120) arranged around a main body of a vehicle (100), for sensing an obstacle around the vehicle;

   obstacle detecting means (115) for detecting presence and absence of an obstacle in a moving direction of the vehicle (100) and detecting size and position of the obstacle by receiving signals from the environment sensors (120);

   on-vehicle memory means (116) storing dimension of the vehicle (100);

   environment information calculating means (117) for calculating environmental data around the vehicle (100) based on information from said obstacle detecting means (115) and said on-vehicle memory means (116); and

   informing means (160) for acquiring the environmental information around the vehicle (100) obtained in said environment information calculating means (117) to inform a driving guidance information.

2. A driving support system according to claim 1, comprising a vehicle body sensor (130) to detect both the direction and the speed of a vehicle and body motion detecting means (114) to detect the vehicle motion by receiving signals from said body sensor (130).

3. A driving support system according to claim 1 or 2, said informing means (160) displays the guidance information as a visual information form.

4. A driving support system according to at least one of claims 1 to 3, said informing means (160) outputs the guidance information as an aural information form.

5. A driving support system according to at least one of claims 1 to 4, said informing means (160) outputs the guidance information as a tactile information form.

6. A driving support system according to at least one of claims 1 to 5, further comprising a controller to control operation means for operating running of a vehicle based on said guidance information.

7. A driving support system according to at least one of claims 1 to 6, said body sensor (130) comprises a wheel rotating speed detector (133) to detect the rotating speed of wheel, a wheel rotating direction detector (134) to detect the rotating direction of wheel and a steering wheel angle detector (135) to detect the rotational angle of steering wheel.

8. A driving support system according to at least one of claims 1 to 7, said environment sensor (120) comprises a TV camera (124) to detect obstacles ahead as image information, and a distributed proximity sensor (125) mounted on the periphery of the vehicle body (100) to detect nearby obstacles through a non-contacting way.

9. A driving support system according to at least one of claims 1 to 8, said obstacle detecting means (115) obtains the information on the obstacles which may interfere with the vehicle motion through processing the environment data from the environment sensor (120) and the motion data from the body motion detecting means (130).

10. A driving support system according to at least one of claims 1 to 9, said informing means (160) comprises a display unit to display a picture showing a vehicle (100) and its surroundings seen from the upper side.

11. A vehicle guidance information system comprising a vehicle body sensor (130) to detect both the direction and the speed of a vehicle, body motion

detecting means (114) to detect the vehicle motion by receiving signal from said body sensor (130), an environment sensor (120) mounted on the periphery of the vehicle body (100) to detect nearby obstacles, obstacle detecting means (115) to receive signals from said vehicle motion detecting means (114, 130) and said environment sensor (120) and to detect the presence/absence of obstacles in the running direction of the vehicle, as well as the size, shape, location of the obstacle when any obstacle exists, an information memory (116) on vehicle in which vehicle dimensions, map information and the like are stored, communicating means (140) to communicate with a ground or satellite communication system or another vehicle's communication system to obtain wide ranged information around the vehicle, environment information processing means (117) to calculate the wide ranged environment information around the vehicle based on the information from said body motion detecting means (130, 114), said obstacle detecting means (115), said information memory (116) on vehicle and said communication means (140), guidance information selecting means (118) to receive the environment information calculated by said environment information processing means (117) and to select the vehicle guidance information among said information based on decision criteria on safety, allowance and so on, and informing means (160) to inform the selected guidance information.

**12.** A vehicle guidance information system according to claim 11, said informing means (160) comprises a display unit to display a wide ranged bird's-eye view map around the vehicle based on the environment map information obtained through said communication means (140), as well as to make said vehicle guidance information overlap on said bird's-eye view map for display.

**13.** A vehicle having a vehicle driving support system comprising:

environment sensors (120) arranged around a main body of a vehicle (100), for sensing an obstacle around the vehicle;

obstacle detecting means (115) for detecting presence and absence of an obstacle in a moving direction of the vehicle (100) and detecting size and position of the obstacle by receiving signals from the environment sensors (120);

on-vehicle memory means (116) storing dimension of the vehicle (100);

environment information calculating means (117) for calculating environmental data around the vehicle (100) based on information from said obstacle detecting means (115) and said on-vehicle memory means (116); and

display means (160) for acquiring the environmental information around the vehicle (100) obtained in said environment information calculating means (117) to display as a picture showing a vehicle (100) and its surroundings seeing from the upper side.

FIG. 1

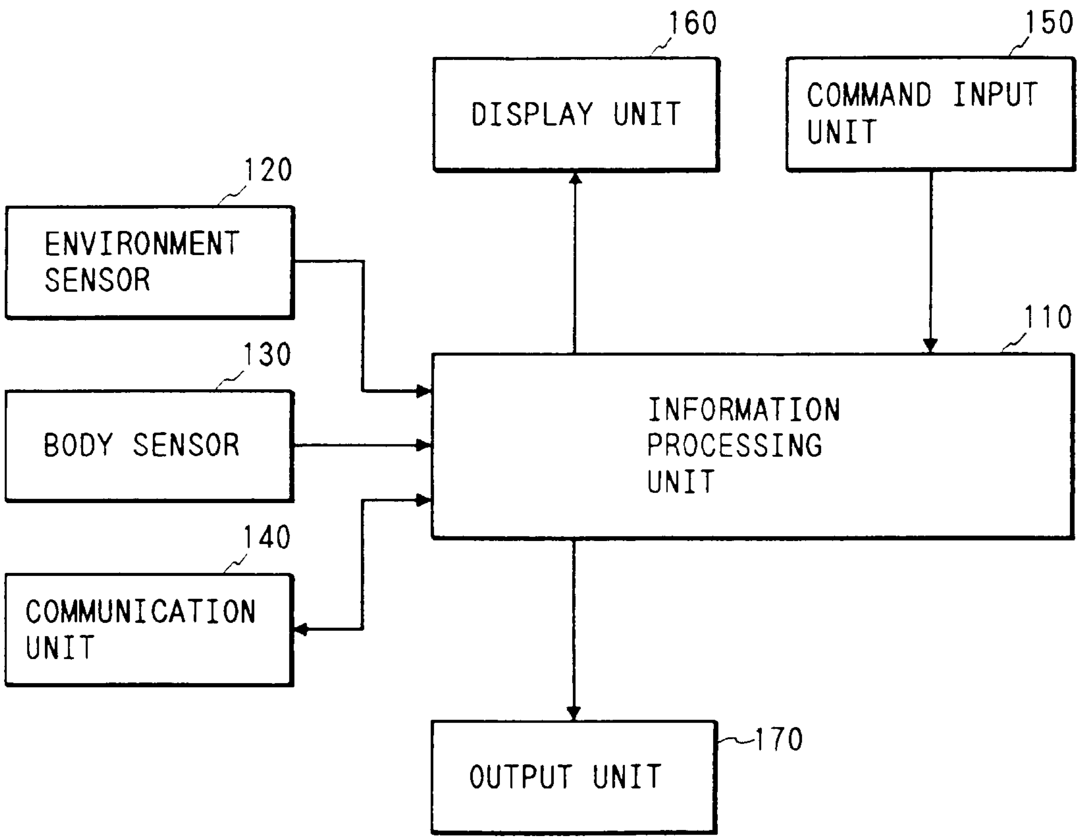

160
150
DISPLAY UNIT
COMMAND INPUT UNIT
120
ENVIRONMENT SENSOR
110
130
BODY SENSOR
INFORMATION PROCESSING UNIT
140
COMMUNICATION UNIT
OUTPUT UNIT
170

FIG. 2

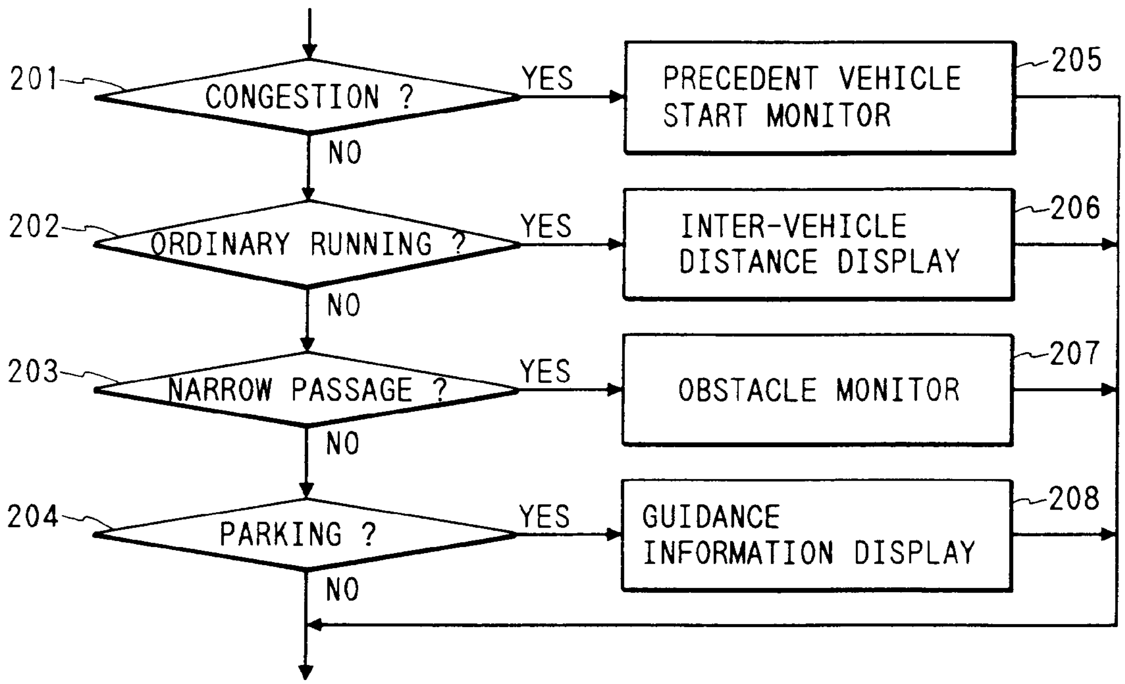

201
CONGESTION ?
YES
NO
PRECEDENT VEHICLE
START MONITOR
205
202
ORDINARY RUNNING ?
YES
NO
INTER-VEHICLE
DISTANCE DISPLAY
206
203
NARROW PASSAGE ?
YES
NO
OBSTACLE MONITOR
207
204
PARKING ?
YES
NO
GUIDANCE
INFORMATION DISPLAY
208

FIG. 3

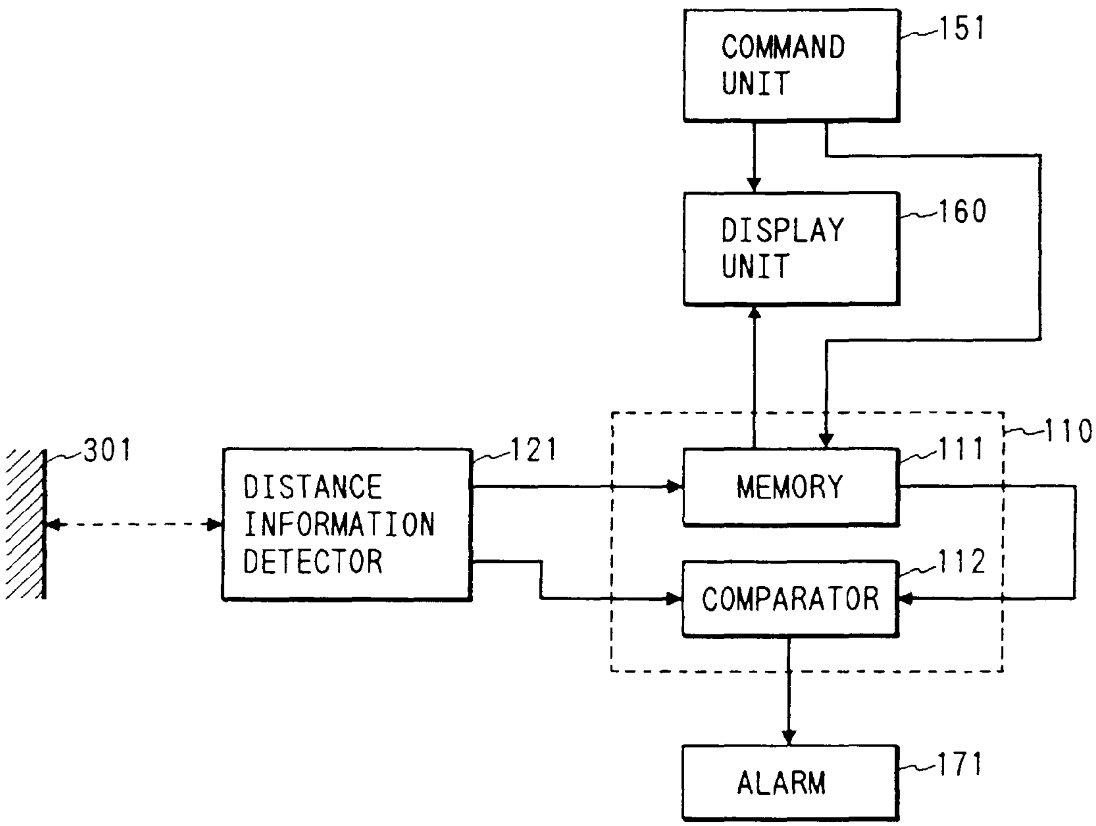

COMMAND UNIT
151
DISPLAY UNIT
160
110
301
DISTANCE INFORMATION DETECTOR
121
MEMORY
111
COMPARATOR
112
ALARM
171

FIG. 4

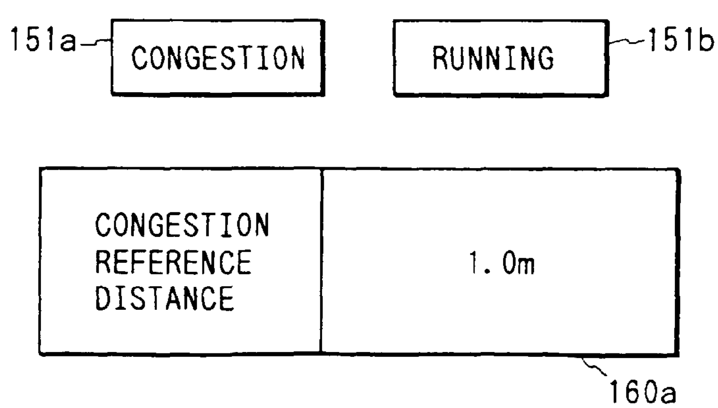

151a
CONGESTION
RUNNING
151b
CONGESTION REFERENCE DISTANCE
1. 0m
160a

FIG. 5

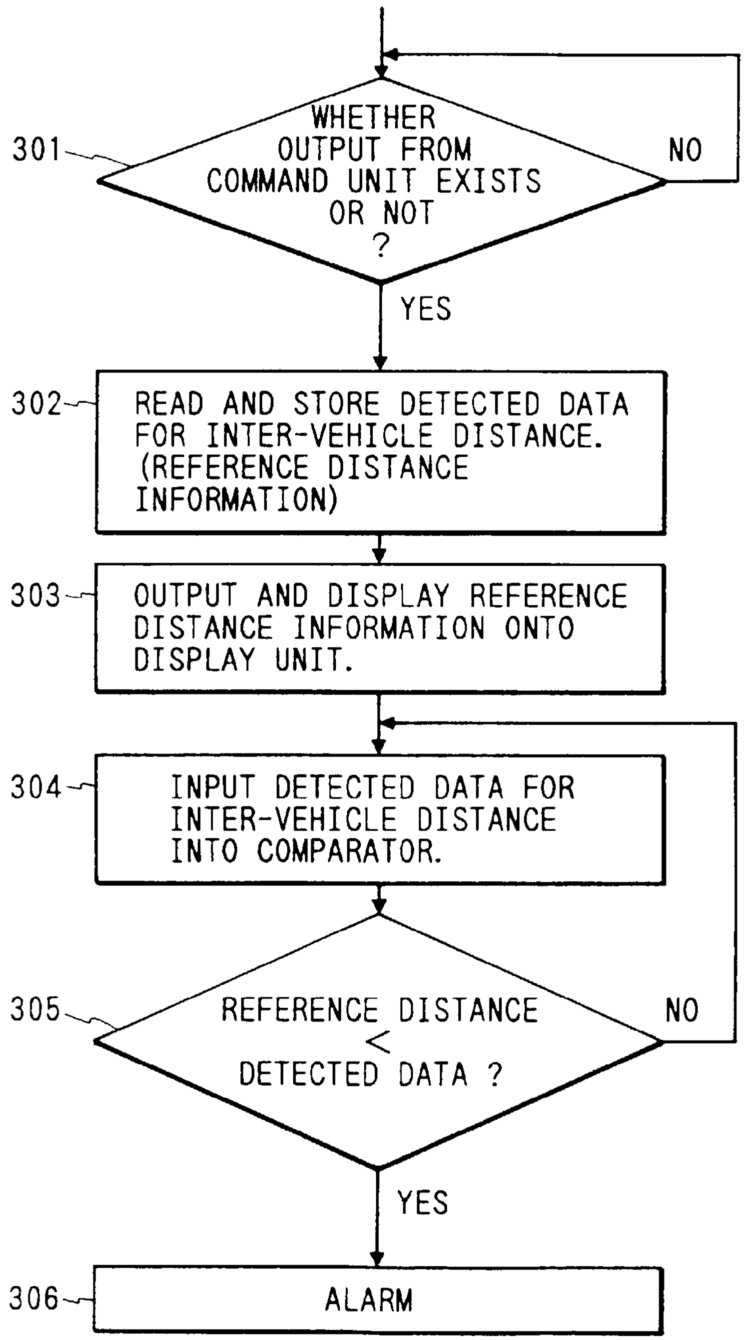
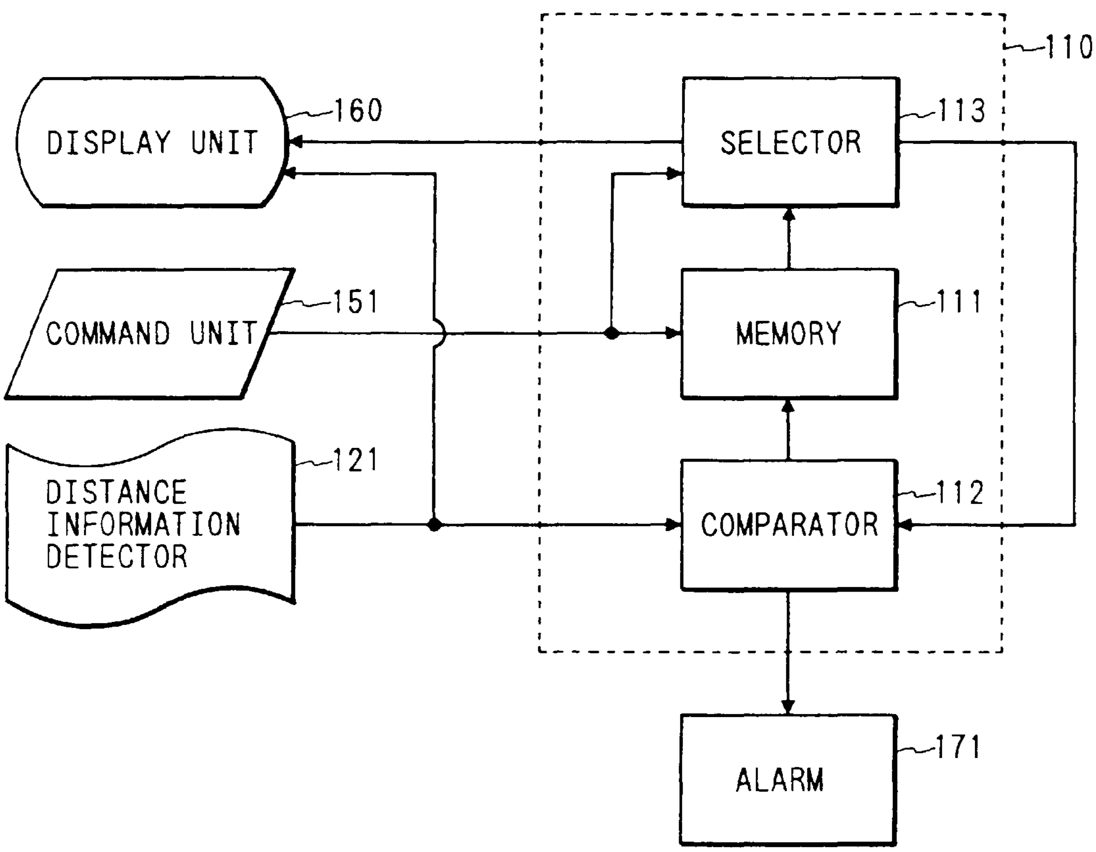

301
WHETHER OUTPUT FROM COMMAND UNIT EXISTS OR NOT ?
NO
YES
302
READ AND STORE DETECTED DATA FOR INTER-VEHICLE DISTANCE. (REFERENCE DISTANCE INFORMATION)
303
OUTPUT AND DISPLAY REFERENCE DISTANCE INFORMATION ONTO DISPLAY UNIT.
304
INPUT DETECTED DATA FOR INTER-VEHICLE DISTANCE INTO COMPARATOR.
305
REFERENCE DISTANCE < DETECTED DATA ?
NO
YES
306
ALARM

FIG. 6



110
DISPLAY UNIT
160
SELECTOR
113
COMMAND UNIT
151
MEMORY
111
DISTANCE INFORMATION DETECTOR
121
COMPARATOR
112
ALARM
171

FIG. 7

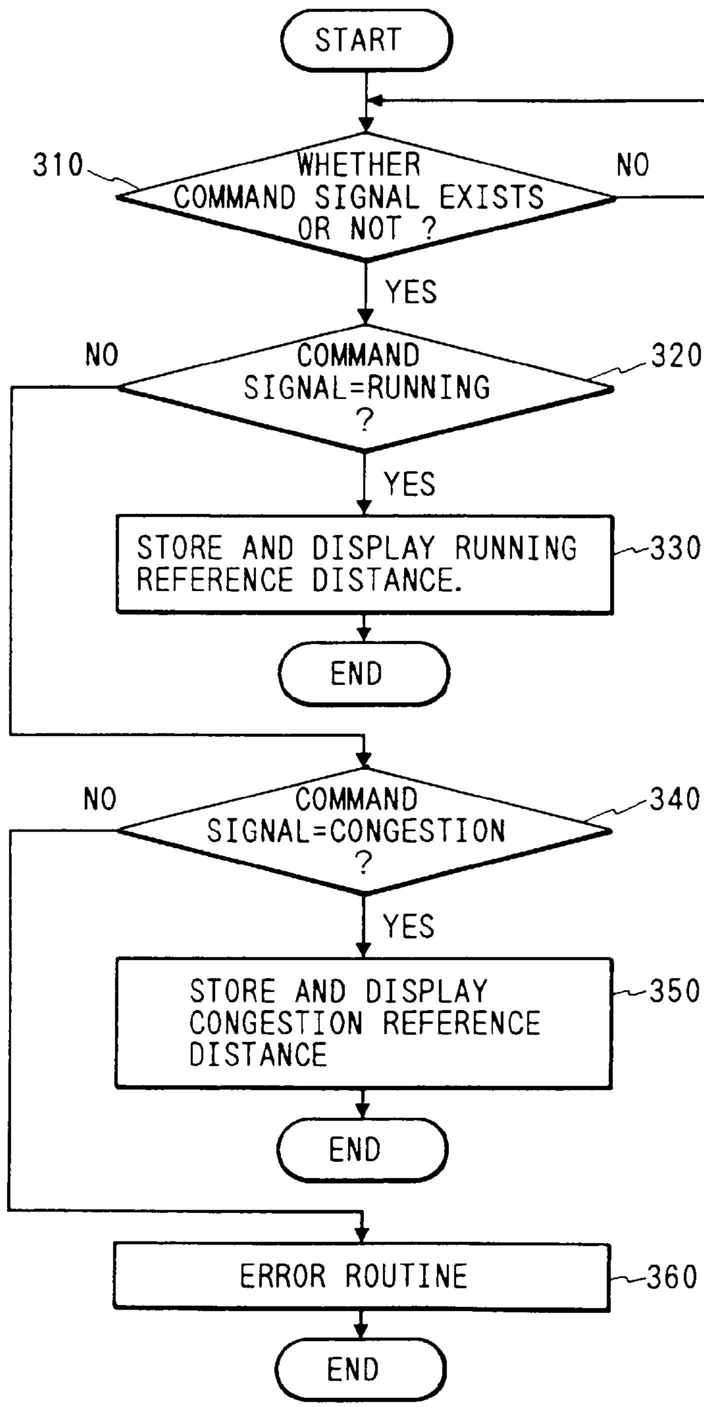

START
310
WHETHER COMMAND SIGNAL EXISTS OR NOT ?
NO
YES
NO
COMMAND SIGNAL=RUNNING ?
320
YES
STORE AND DISPLAY RUNNING REFERENCE DISTANCE.
330
END
NO
COMMAND SIGNAL=CONGESTION ?
340
YES
STORE AND DISPLAY CONGESTION REFERENCE DISTANCE
350
END
ERROR ROUTINE
360
END

FIG. 8

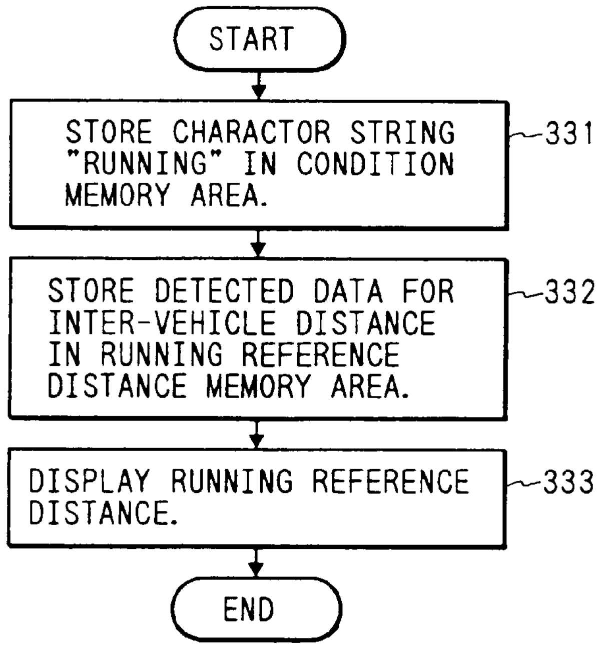

START
STORE CHARACTOR STRING "RUNNING" IN CONDITION MEMORY AREA.
331
STORE DETECTED DATA FOR INTER-VEHICLE DISTANCE IN RUNNING REFERENCE DISTANCE MEMORY AREA.
332
DISPLAY RUNNING REFERENCE DISTANCE.
333
END

FIG. 9

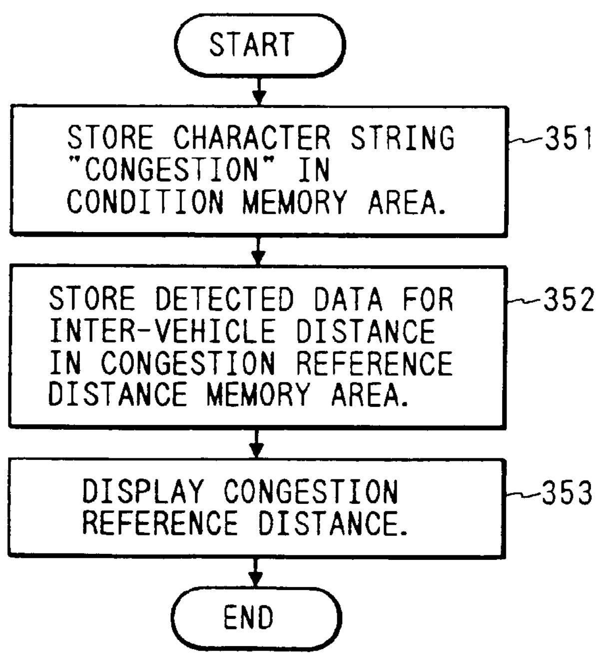

START
STORE CHARACTER STRING "CONGESTION" IN CONDITION MEMORY AREA.
351
STORE DETECTED DATA FOR INTER-VEHICLE DISTANCE IN CONGESTION REFERENCE DISTANCE MEMORY AREA.
352
DISPLAY CONGESTION REFERENCE DISTANCE.
353
END

FIG. 10

160a

| | |
|---|---|
| RUNNING REFERENCE DISTANCE | 10.0m |

FIG. 11

160a

| | |
|---|---|
| CONGESTION REFERENCE DISTANCE | 1.0m |

FIG. 12

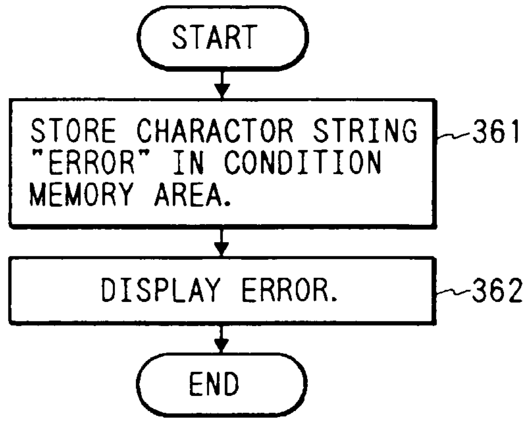

START
STORE CHARACTOR STRING "ERROR" IN CONDITION MEMORY AREA.
361
DISPLAY ERROR.
362
END

FIG. 13

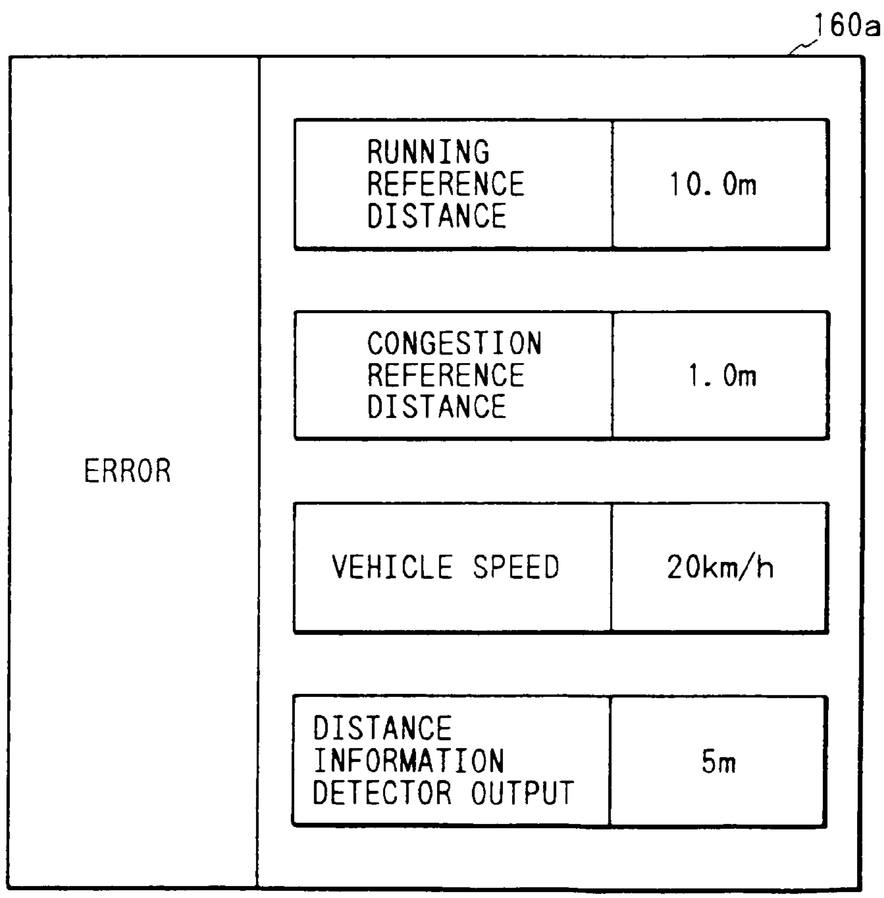

160a
ERROR
RUNNING REFERENCE DISTANCE
10. 0m
CONGESTION REFERENCE DISTANCE
1. 0m
VEHICLE SPEED
20km/h
DISTANCE INFORMATION DETECTOR OUTPUT
5m

FIG. 14

| NAME | DATA |
|---|---|
| CONDITION | CHARACTER STRING |
| RUNNING REFERENCE DISTANCE | NUMERAL |
| CONGESTION REFERENCE DISTANCE | NUMERAL |
| VEHICLE SPEED | NUMERAL |
| DISTANCE INFORMATION DETECTOR OUTPUT | NUMERAL |
| ... | ... |

FIG. 15

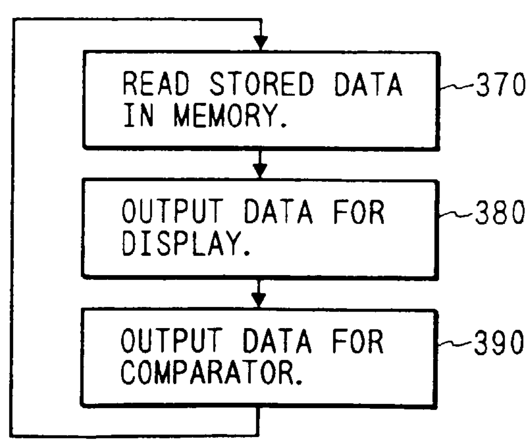


FIG. 16

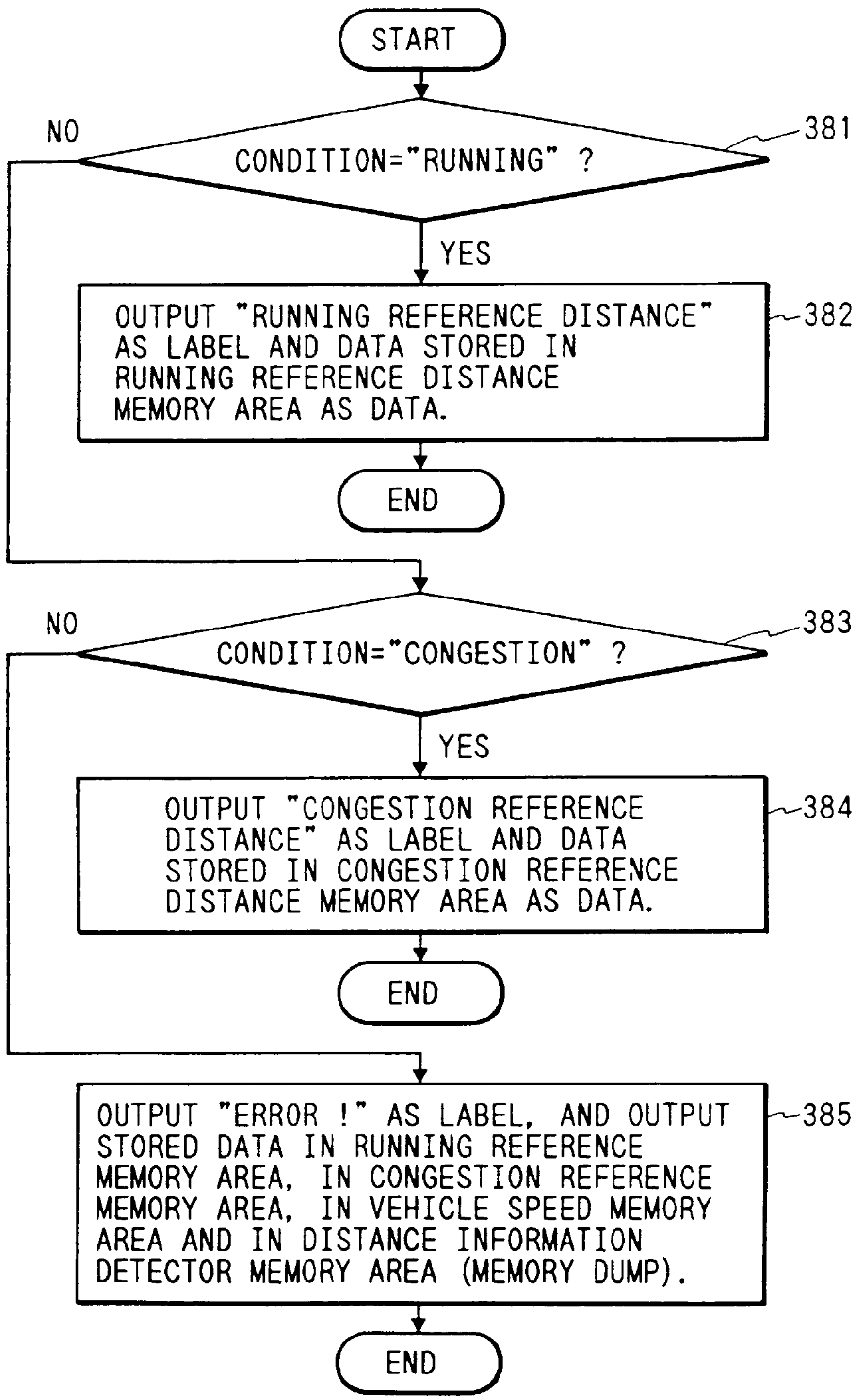

START
NO
CONDITION="RUNNING" ?
381
YES
OUTPUT "RUNNING REFERENCE DISTANCE" AS LABEL AND DATA STORED IN RUNNING REFERENCE DISTANCE MEMORY AREA AS DATA.
382
END
NO
CONDITION="CONGESTION" ?
383
YES
OUTPUT "CONGESTION REFERENCE DISTANCE" AS LABEL AND DATA STORED IN CONGESTION REFERENCE DISTANCE MEMORY AREA AS DATA.
384
END
OUTPUT "ERROR !" AS LABEL, AND OUTPUT STORED DATA IN RUNNING REFERENCE MEMORY AREA, IN CONGESTION REFERENCE MEMORY AREA, IN VEHICLE SPEED MEMORY AREA AND IN DISTANCE INFORMATION DETECTOR MEMORY AREA (MEMORY DUMP).
385
END

FIG. 17

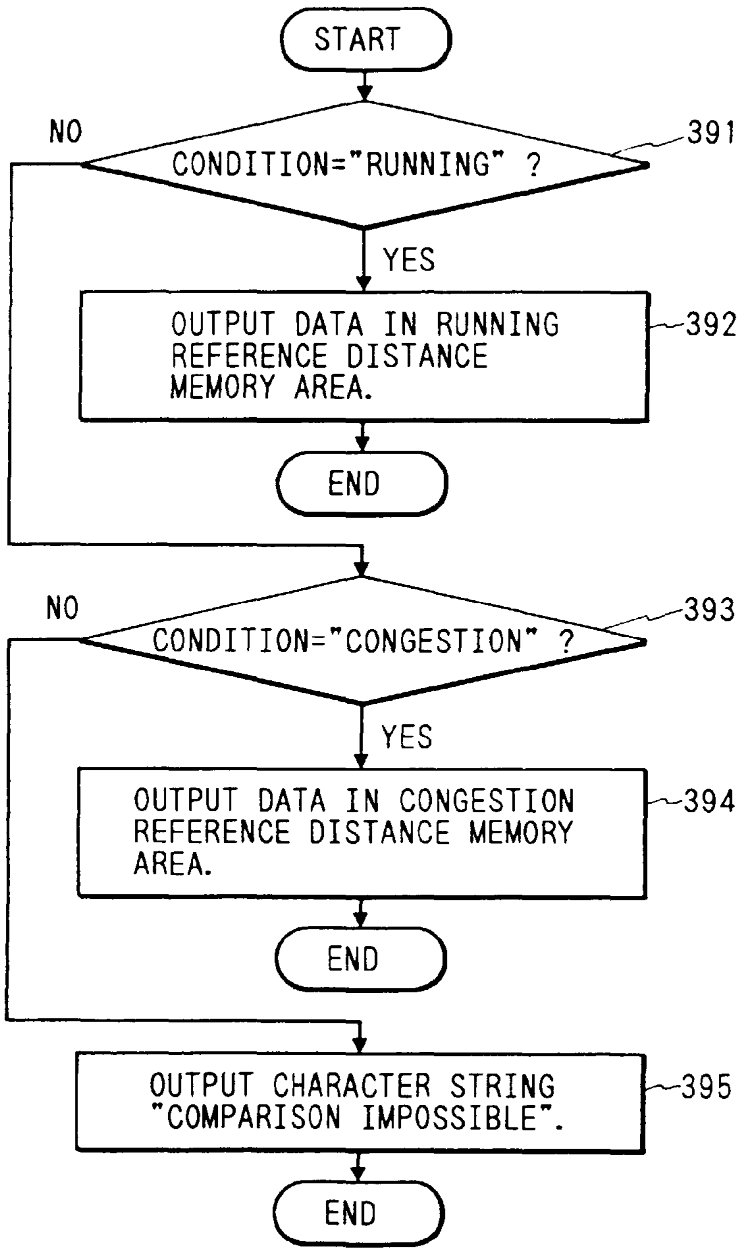

START
NO
CONDITION="RUNNING" ?
391
YES
OUTPUT DATA IN RUNNING REFERENCE DISTANCE MEMORY AREA.
392
END
NO
CONDITION="CONGESTION" ?
393
YES
OUTPUT DATA IN CONGESTION REFERENCE DISTANCE MEMORY AREA.
394
END
OUTPUT CHARACTER STRING "COMPARISON IMPOSSIBLE".
395
END

FIG. 18

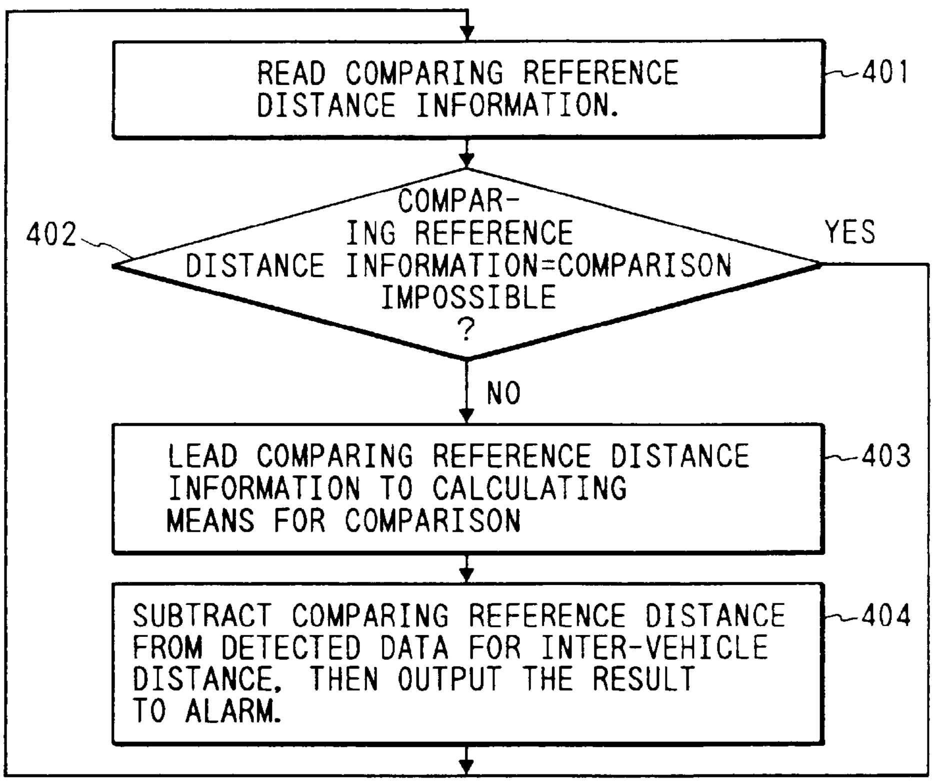

READ COMPARING REFERENCE DISTANCE INFORMATION.
401
COMPARING REFERENCE DISTANCE INFORMATION=COMPARISON IMPOSSIBLE ?
402
YES
NO
LEAD COMPARING REFERENCE DISTANCE INFORMATION TO CALCULATING MEANS FOR COMPARISON
403
SUBTRACT COMPARING REFERENCE DISTANCE FROM DETECTED DATA FOR INTER-VEHICLE DISTANCE, THEN OUTPUT THE RESULT TO ALARM.
404

FIG. 19

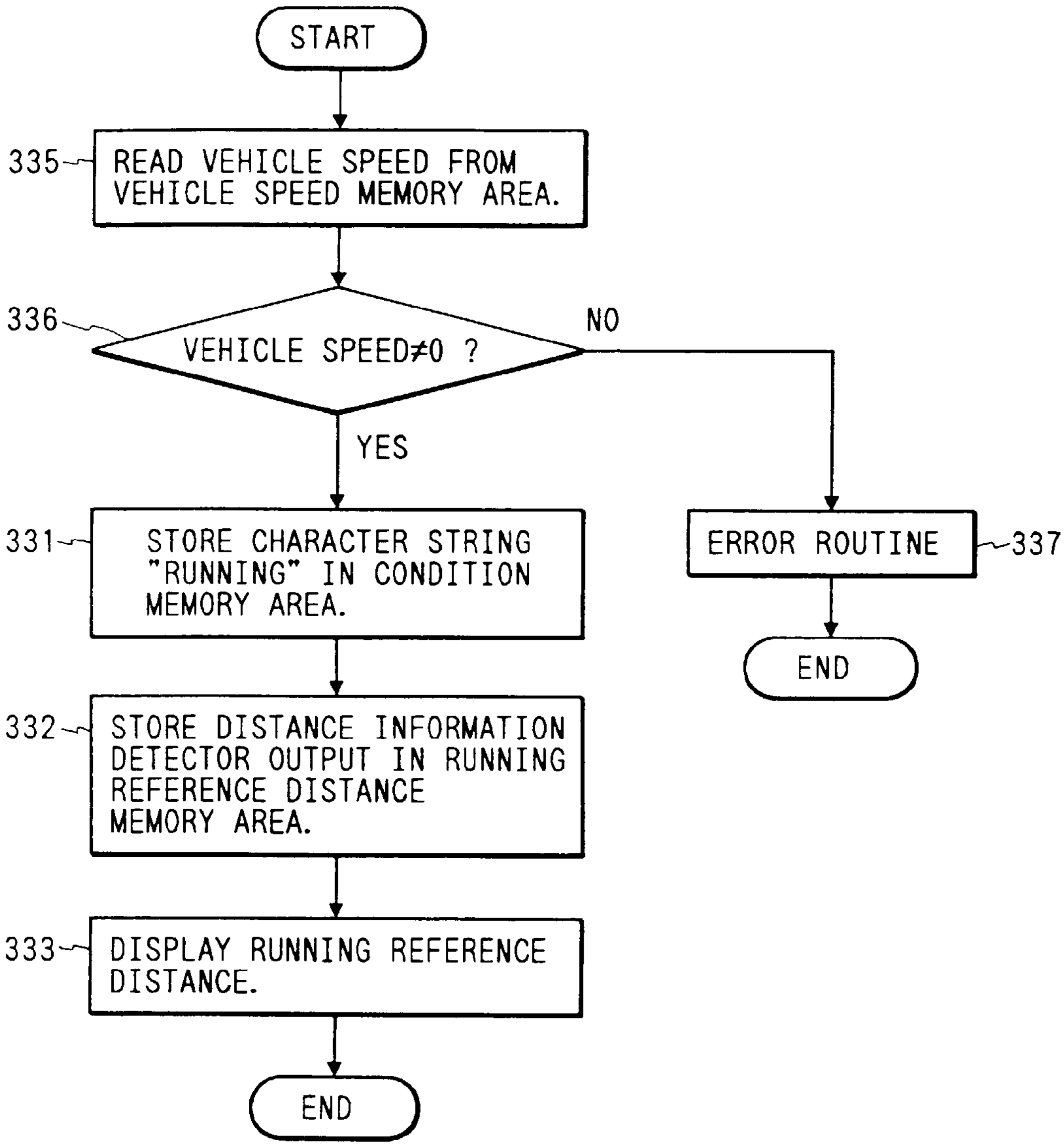

START
335
READ VEHICLE SPEED FROM VEHICLE SPEED MEMORY AREA.
336
VEHICLE SPEED≠0 ?
NO
YES
331
STORE CHARACTER STRING "RUNNING" IN CONDITION MEMORY AREA.
ERROR ROUTINE
337
END
332
STORE DISTANCE INFORMATION DETECTOR OUTPUT IN RUNNING REFERENCE DISTANCE MEMORY AREA.
333
DISPLAY RUNNING REFERENCE DISTANCE.
END

FIG. 20

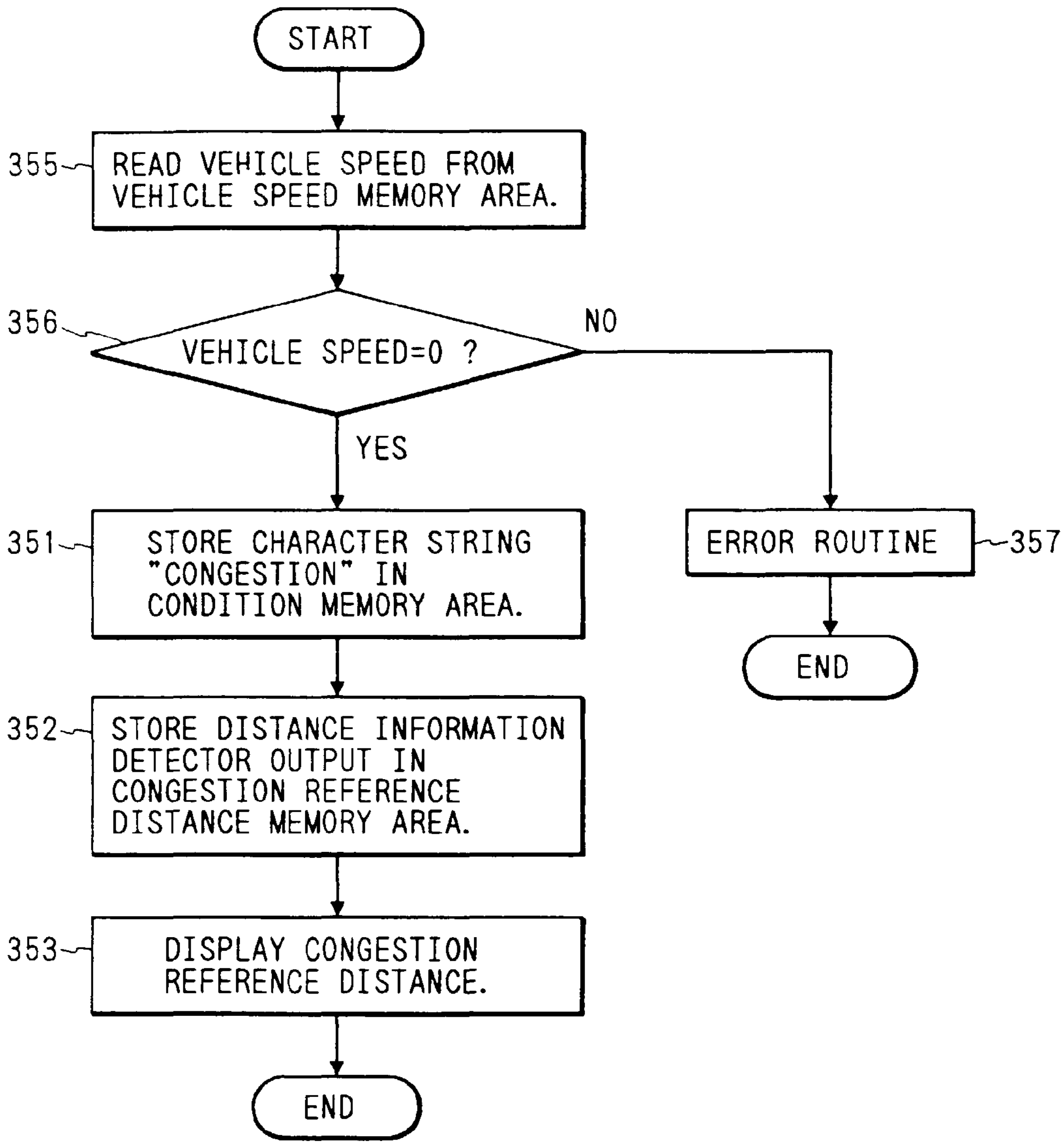
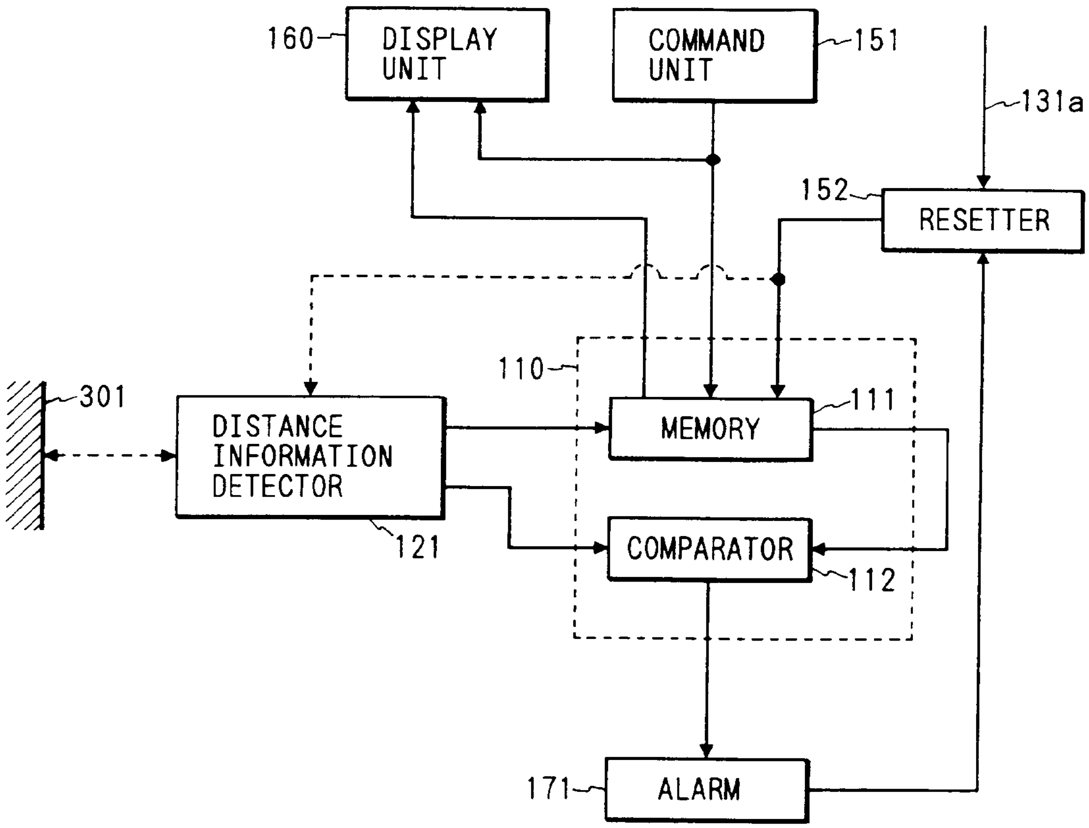
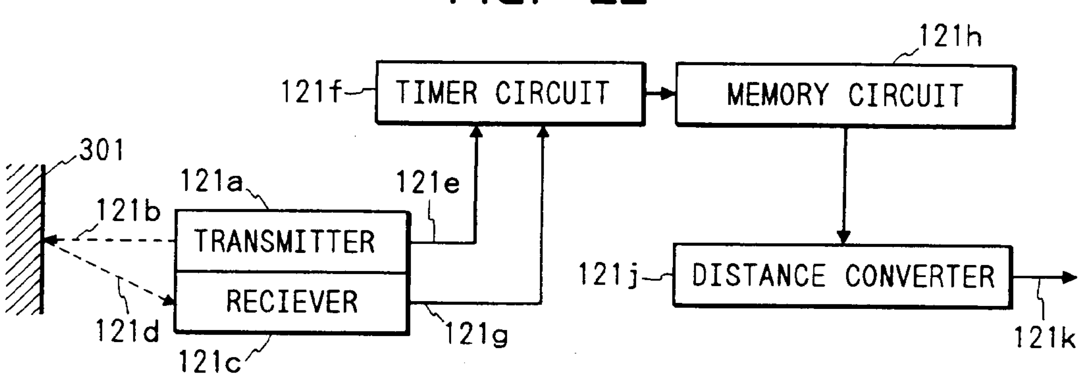

START
355
READ VEHICLE SPEED FROM VEHICLE SPEED MEMORY AREA.
356
VEHICLE SPEED=0 ?
NO
YES
351
STORE CHARACTER STRING "CONGESTION" IN CONDITION MEMORY AREA.
ERROR ROUTINE
357
END
352
STORE DISTANCE INFORMATION DETECTOR OUTPUT IN CONGESTION REFERENCE DISTANCE MEMORY AREA.
353
DISPLAY CONGESTION REFERENCE DISTANCE.
END

FIG. 21



160
DISPLAY UNIT
COMMAND UNIT
151
131a
152
RESETTER
110
301
DISTANCE INFORMATION DETECTOR
MEMORY
111
COMPARATOR
121
112
171
ALARM


FIG. 22



121h
121f
TIMER CIRCUIT
MEMORY CIRCUIT
301
121a
121e
121b
TRANSMITTER
RECIEVER
121d
121c
121g
121j
DISTANCE CONVERTER
121k

FIG. 23

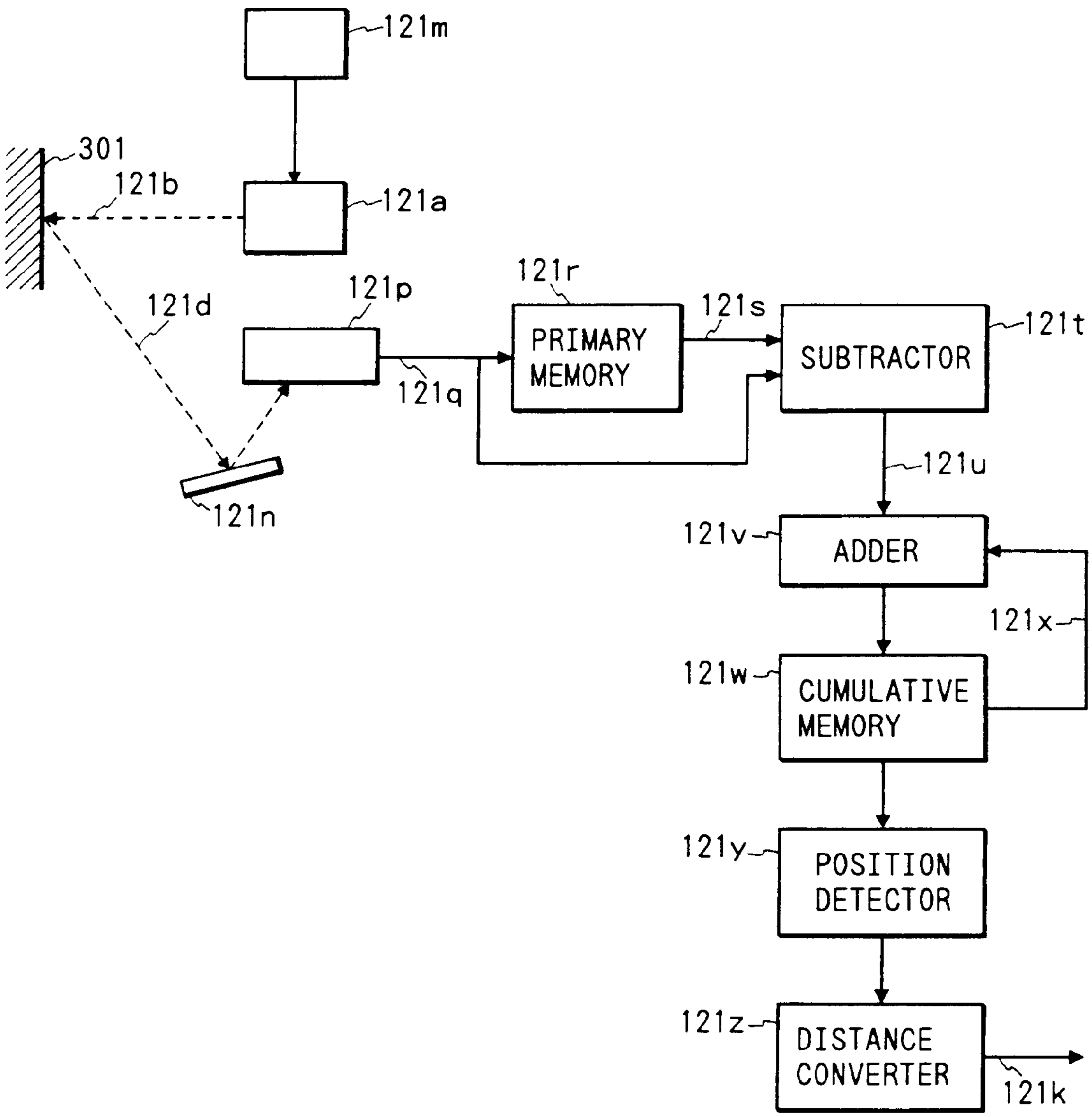

121m
301
121b
121a
121r
121d
121p
121s
PRIMARY MEMORY
SUBTRACTOR
121t
121q
121u
121n
121v
ADDER
121x
121w
CUMULATIVE MEMORY
121y
POSITION DETECTOR
121z
DISTANCE CONVERTER
121k

FIG. 24

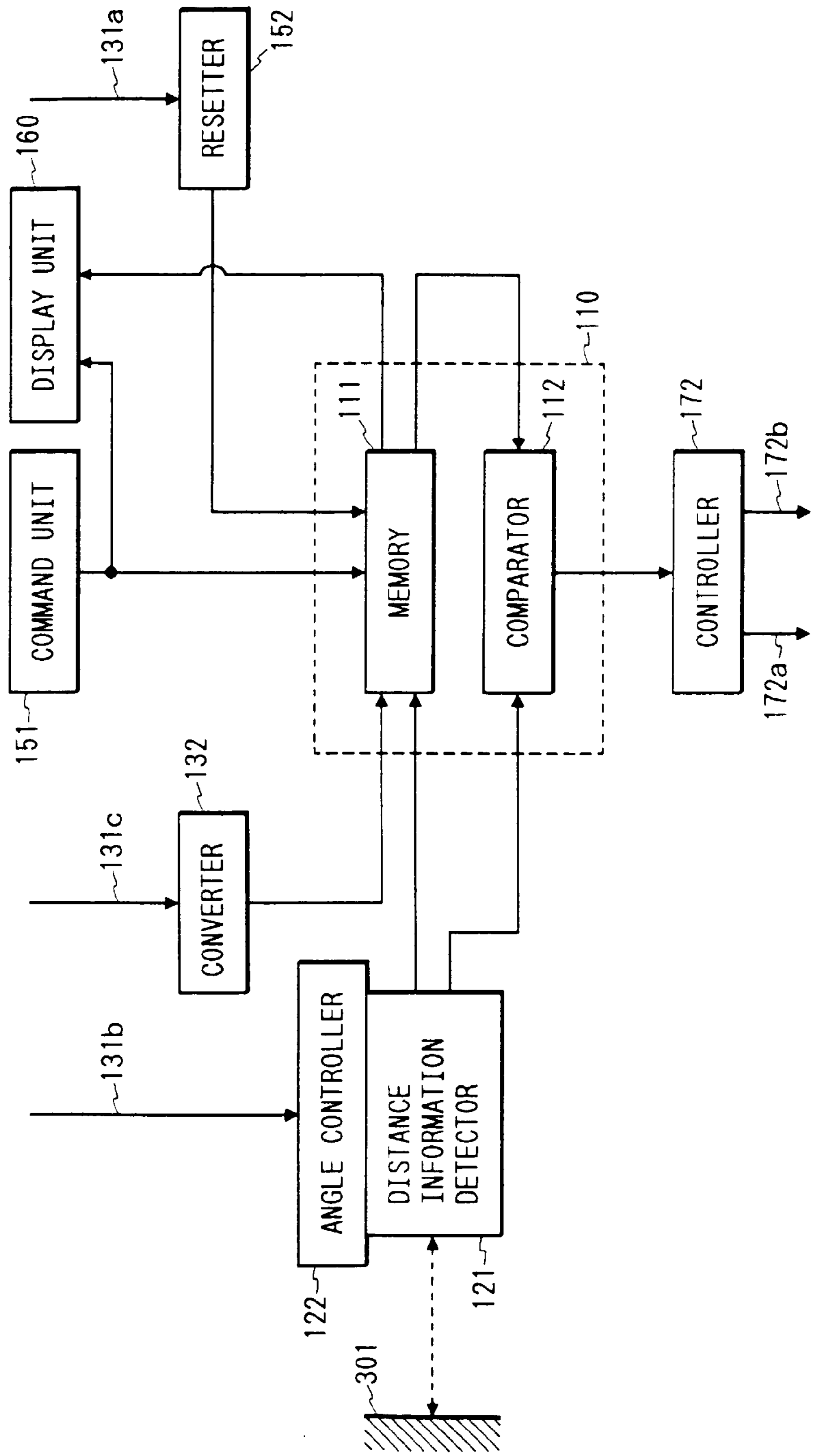

131a
RESETTER
152
160
DISPLAY UNIT
110
111
112
COMMAND UNIT
MEMORY
COMPARATOR
172
CONTROLLER
172b
172a
151
132
131c
CONVERTER
131b
ANGLE CONTROLLER
DISTANCE
INFORMATION
DETECTOR
122
121
301

FIG. 25

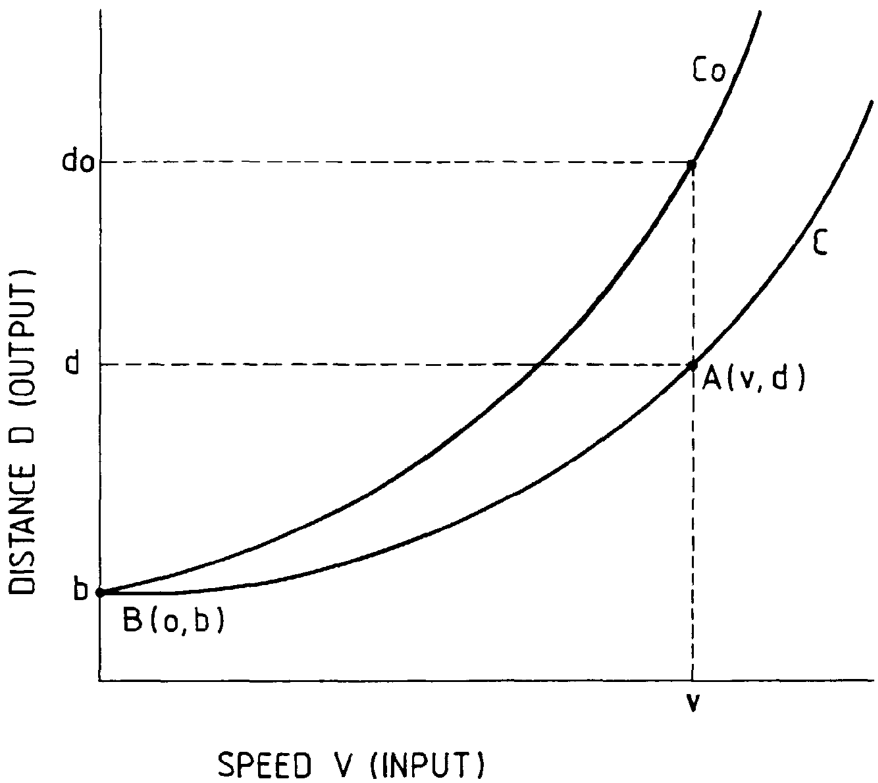


FIG. 26

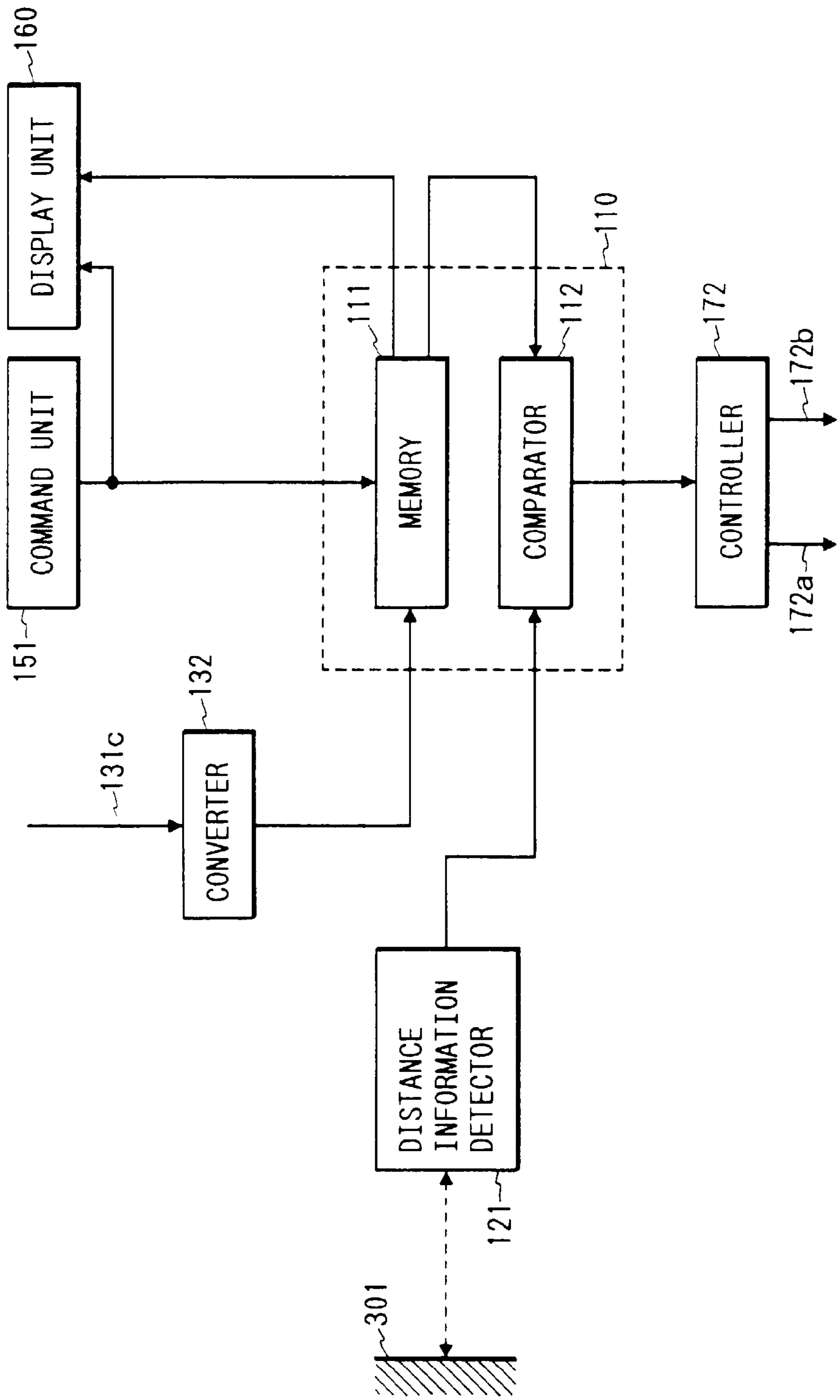

COMMAND UNIT
151
DISPLAY UNIT
160
MEMORY
111
COMPARATOR
112
110
CONTROLLER
172
172a
172b
CONVERTER
132
131c
DISTANCE INFORMATION DETECTOR
121
301

FIG. 27

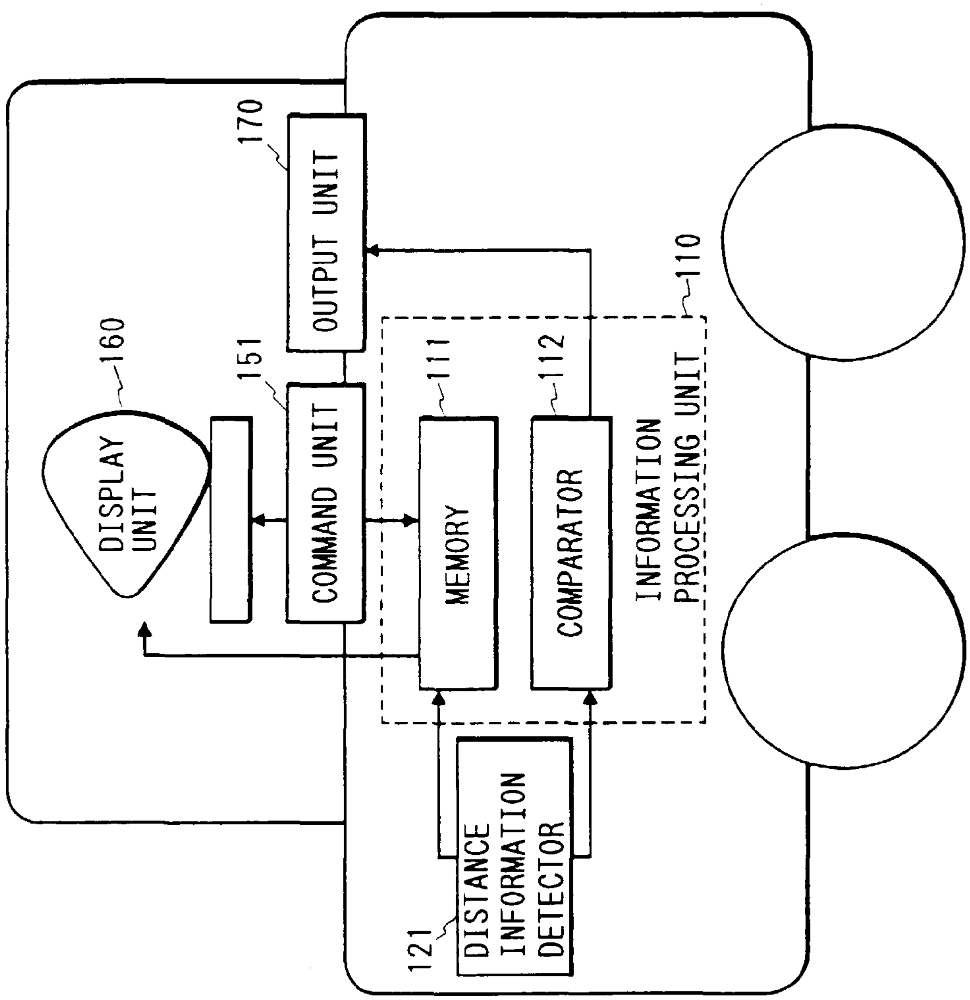

DISPLAY UNIT
160
151
COMMAND UNIT
170
OUTPUT UNIT
111
MEMORY
112
COMPARATOR
INFORMATION PROCESSING UNIT
110
121
DISTANCE INFORMATION DETECTOR

FIG. 28

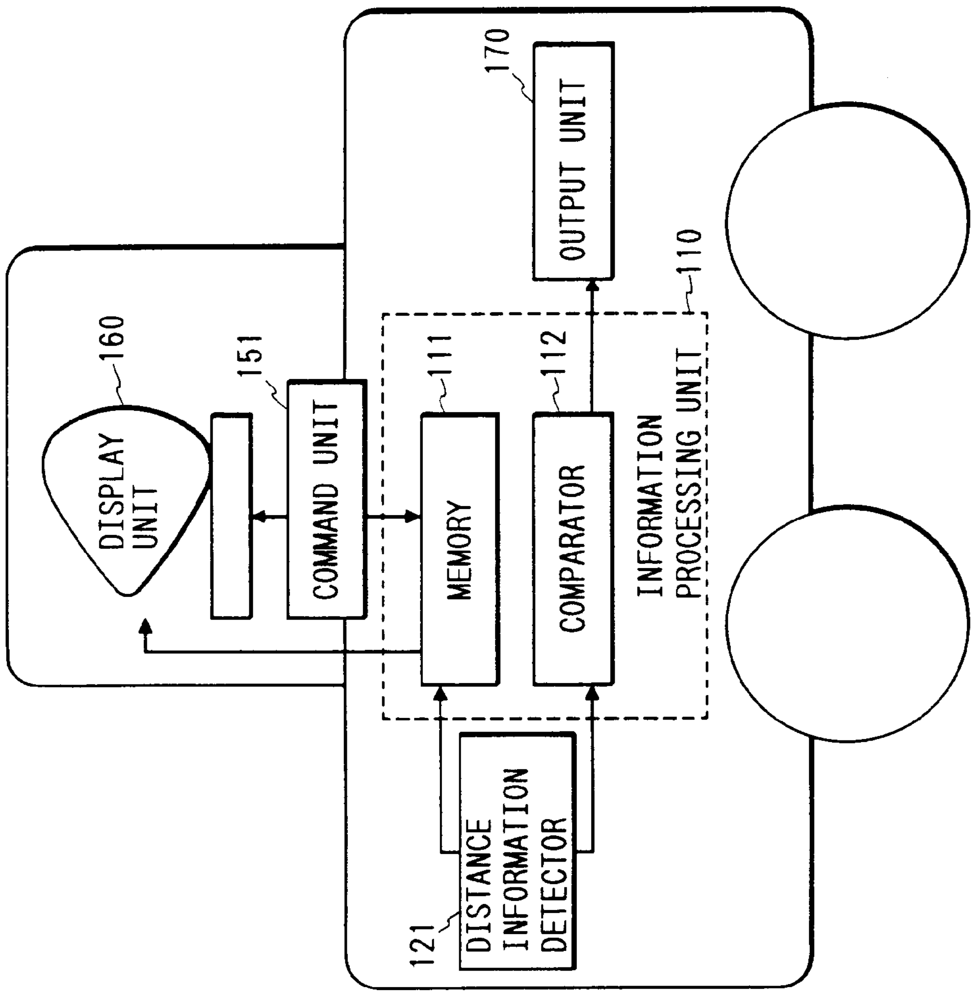

160
DISPLAY UNIT
151
COMMAND UNIT
111
MEMORY
112
COMPARATOR
110
INFORMATION PROCESSING UNIT
170
OUTPUT UNIT
121
DISTANCE INFORMATION DETECTOR

FIG. 29

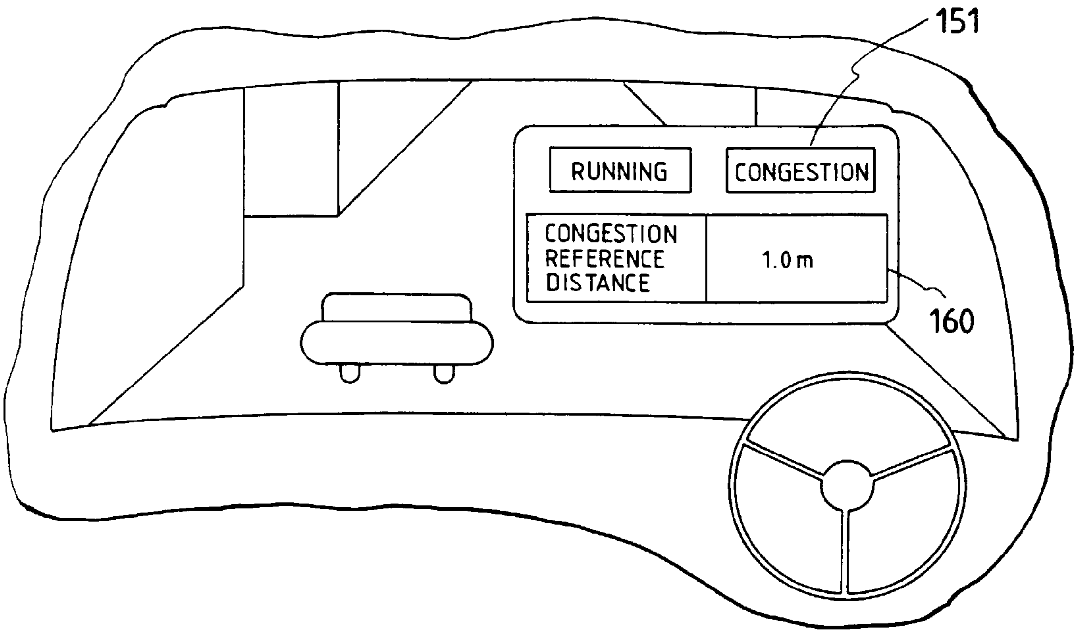

151
RUNNING
CONGESTION
CONGESTION REFERENCE DISTANCE
1.0 m
160

FIG. 30

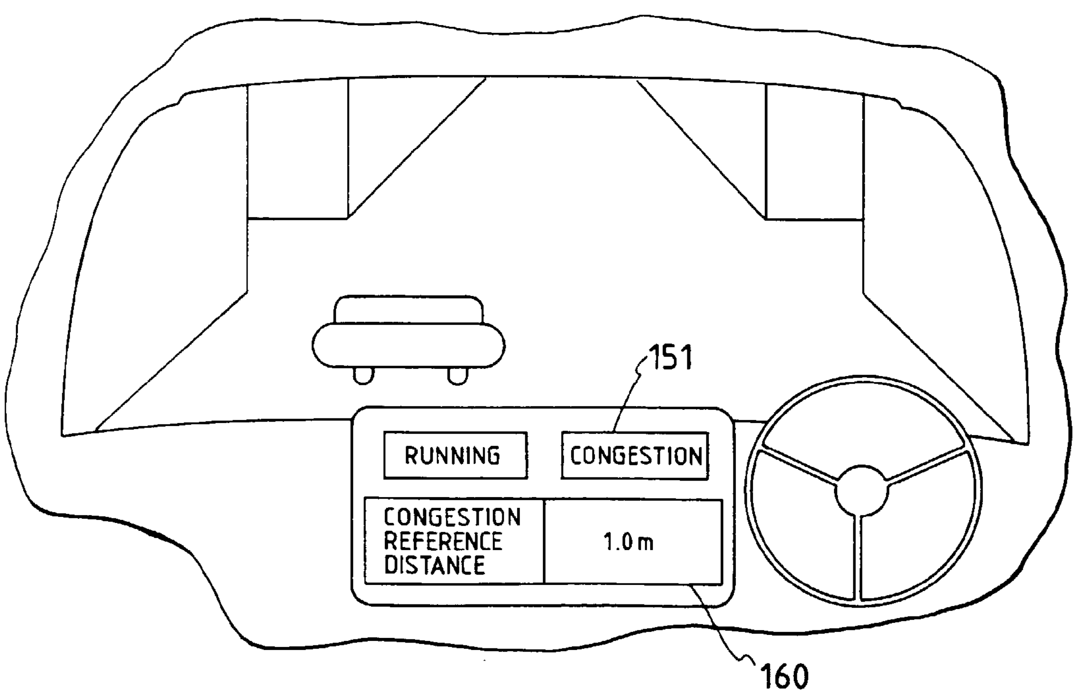

151
RUNNING
CONGESTION
CONGESTION REFERENCE DISTANCE
1.0 m
160

FIG. 31

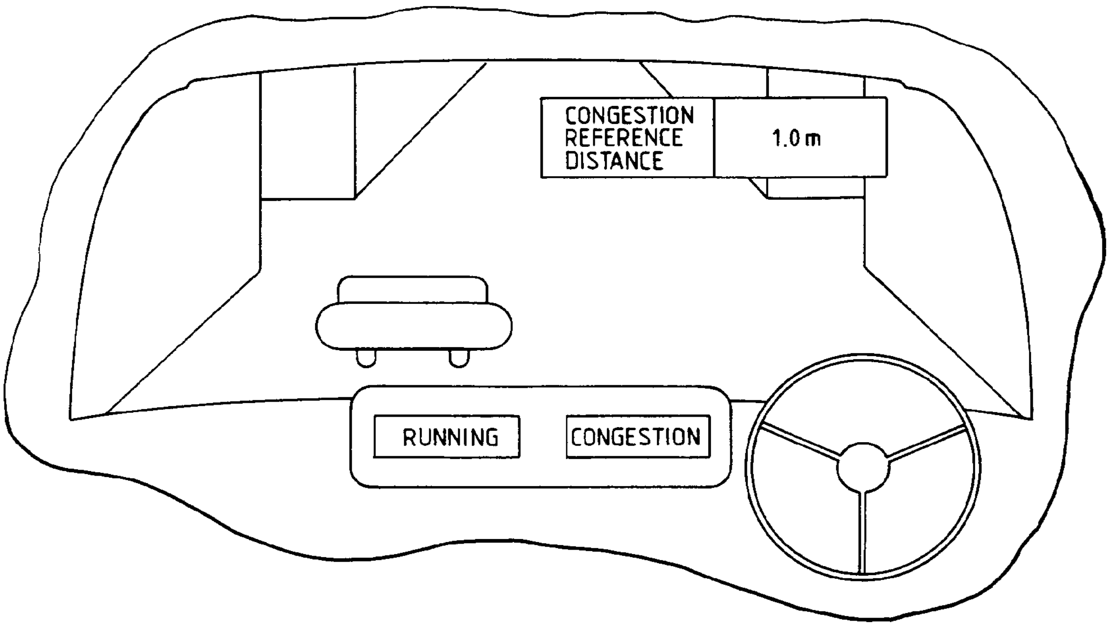

CONGESTION
REFERENCE
DISTANCE
1.0 m
RUNNING
CONGESTION

FIG. 32

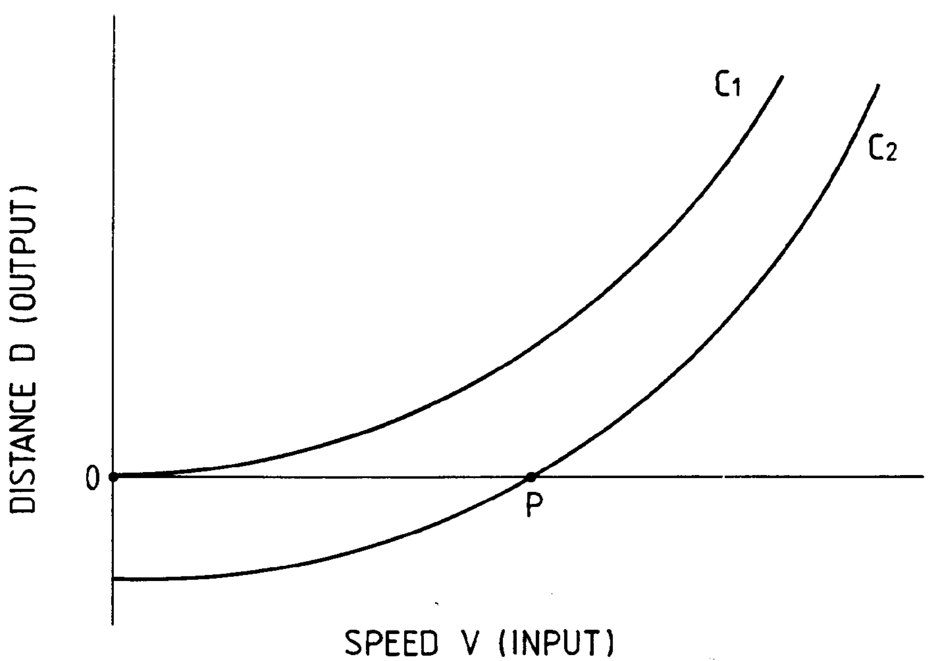

C1
C2
DISTANCE D (OUTPUT)
0
P
SPEED V (INPUT)

FIG. 33

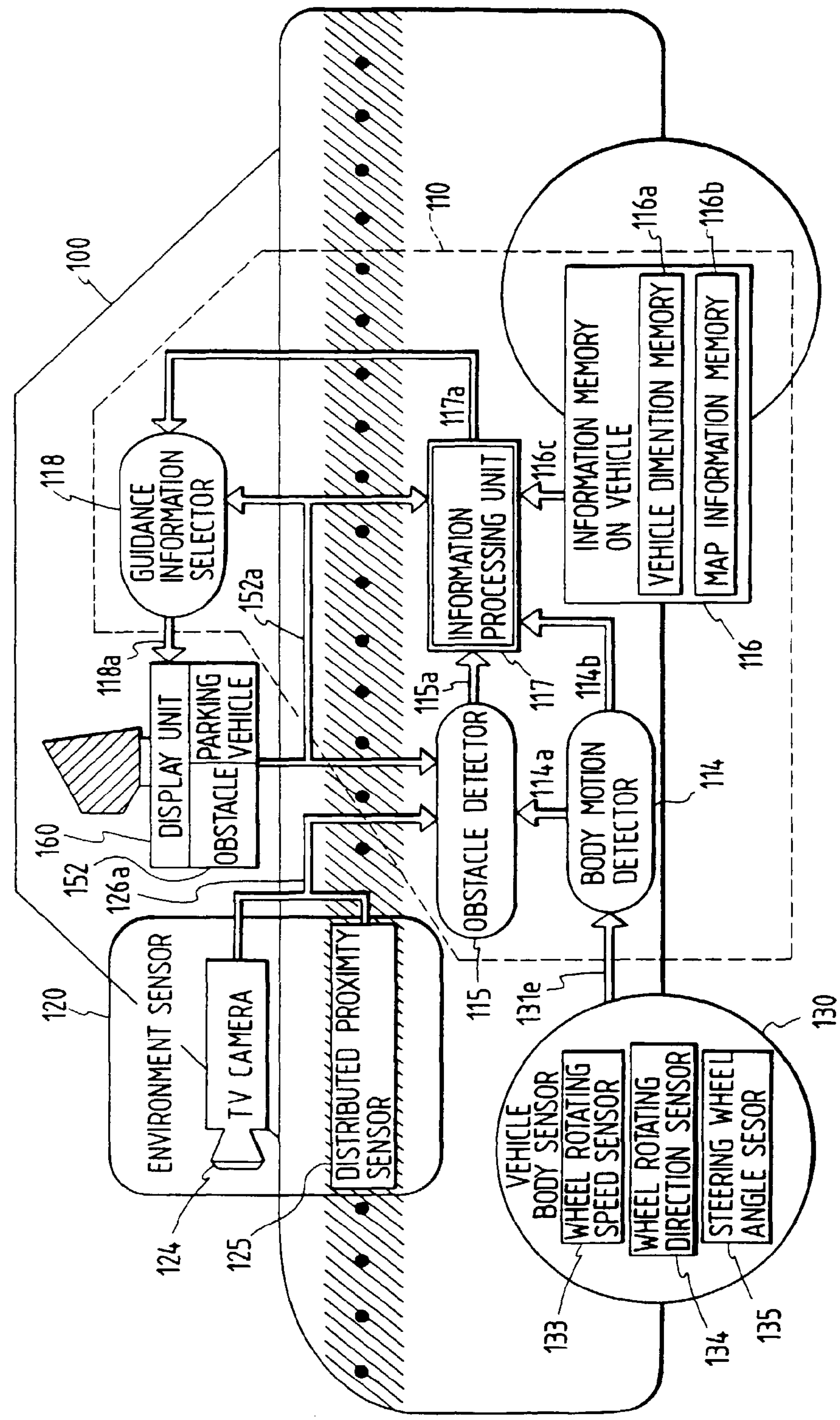

100
110
120
ENVIRONMENT SENSOR
TV CAMERA
DISTRIBUTED PROXIMITY SENSOR
124
125
126a
152
152a
160
DISPLAY UNIT
OBSTACLE
PARKING VEHICLE
118
118a
GUIDANCE INFORMATION SELECTOR
117
117a
INFORMATION PROCESSING UNIT
115
115a
OBSTACLE DETECTOR
114
114a
114b
BODY MOTION DETECTOR
116
116a
116b
116c
INFORMATION MEMORY ON VEHICLE
VEHICLE DIMENTION MEMORY
MAP INFORMATION MEMORY
130
131e
VEHICLE BODY SENSOR
WHEEL ROTATING SPEED SENSOR
WHEEL ROTATING DIRECTION SENSOR
STEERING WHEEL ANGLE SESOR
133
134
135

FIG. 34

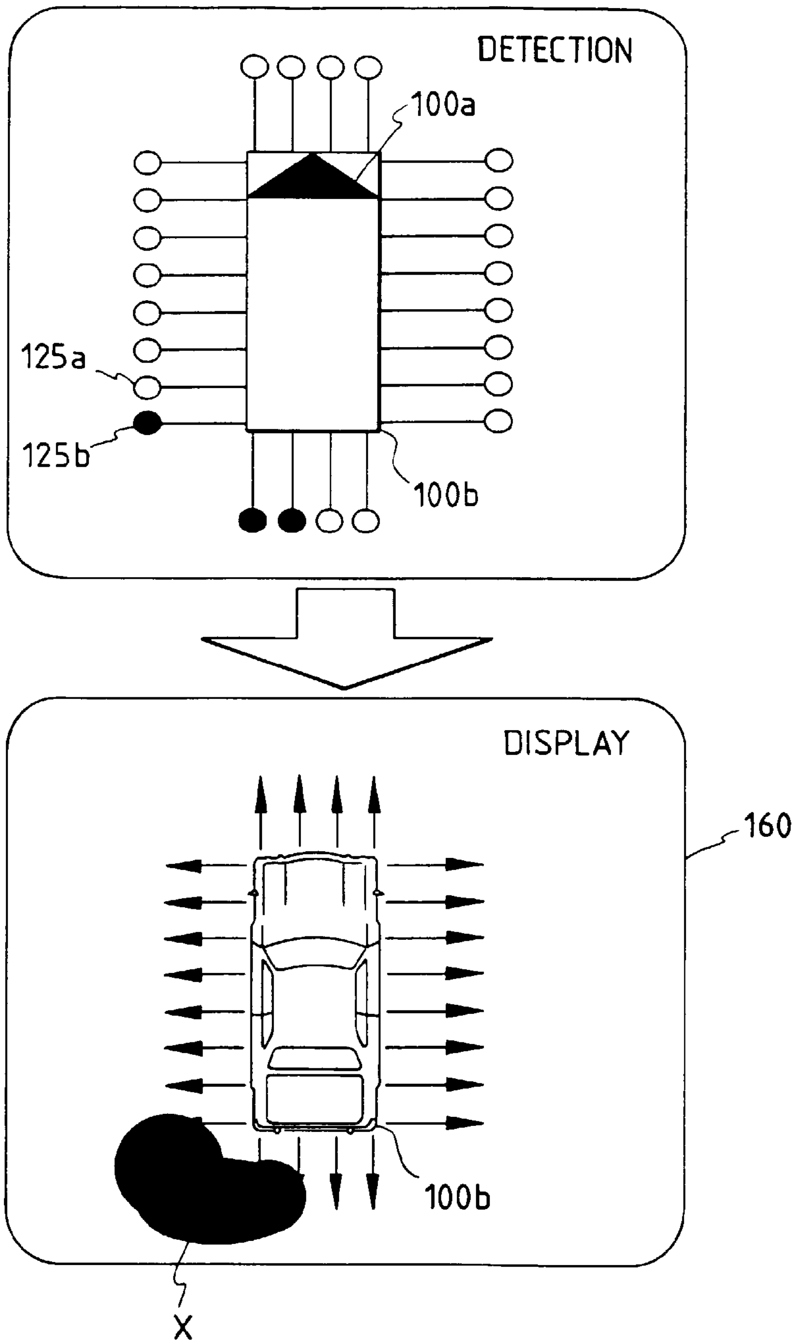


FIG. 35

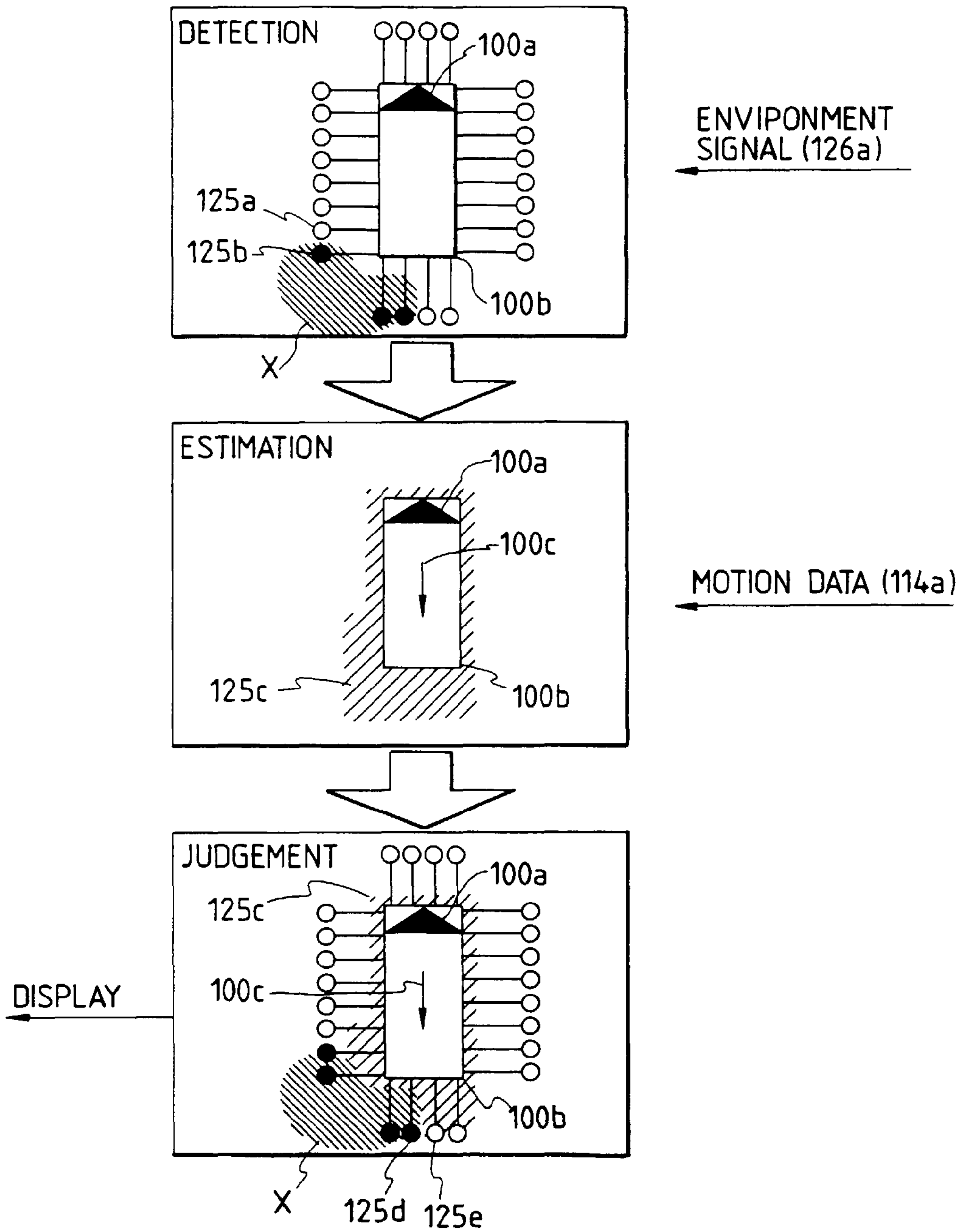

DETECTION
100a
ENVIPONMENT
SIGNAL (126a)
125a
125b
100b
X
ESTIMATION
100a
100c
MOTION DATA (114a)
125c
100b
JUDGEMENT
100a
125c
DISPLAY
100c
100b
X
125d
125e

FIG. 36

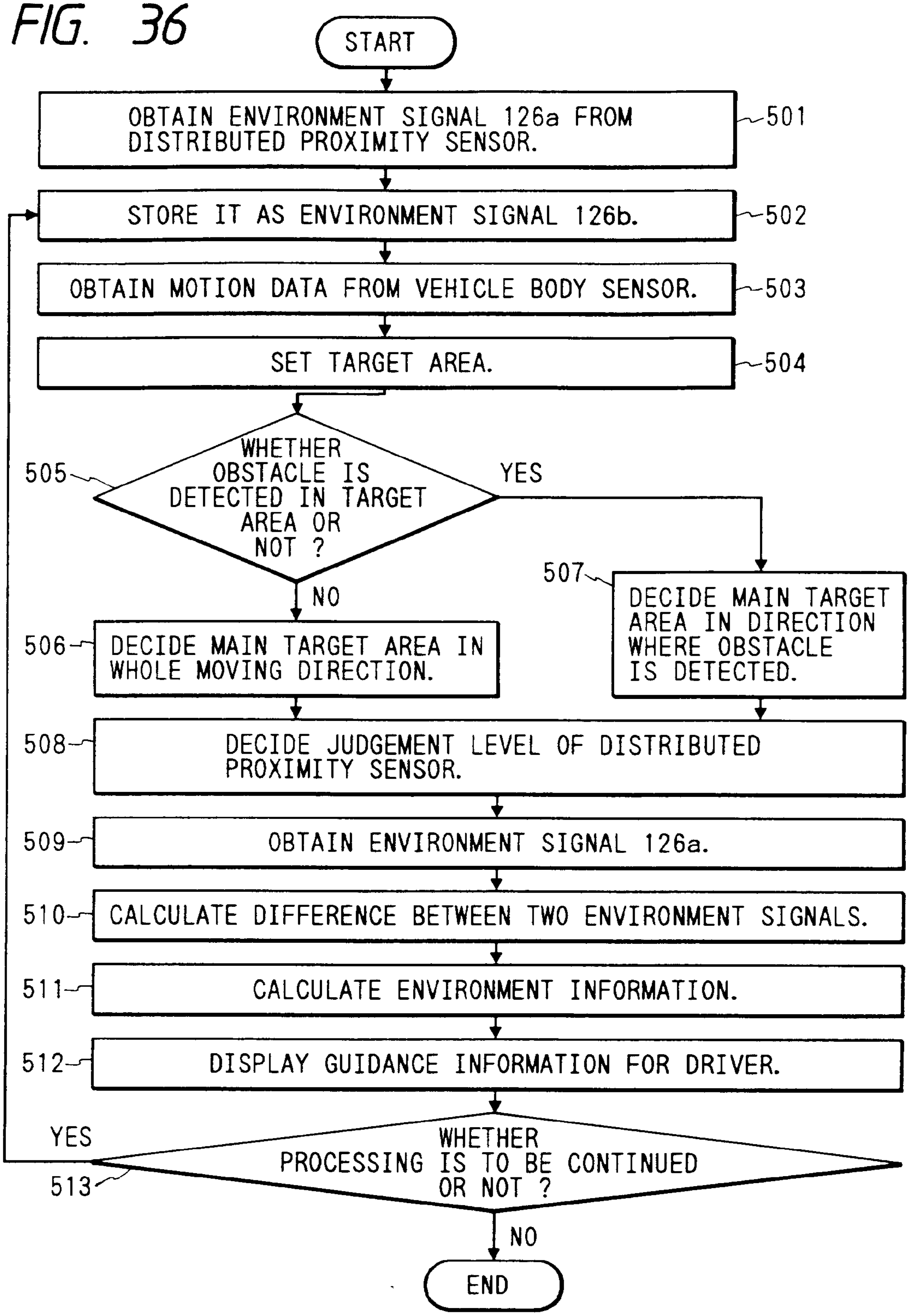

START
OBTAIN ENVIRONMENT SIGNAL 126a FROM DISTRIBUTED PROXIMITY SENSOR.
501
STORE IT AS ENVIRONMENT SIGNAL 126b.
502
OBTAIN MOTION DATA FROM VEHICLE BODY SENSOR.
503
SET TARGET AREA.
504
505
WHETHER OBSTACLE IS DETECTED IN TARGET AREA OR NOT ?
YES
NO
506
DECIDE MAIN TARGET AREA IN WHOLE MOVING DIRECTION.
507
DECIDE MAIN TARGET AREA IN DIRECTION WHERE OBSTACLE IS DETECTED.
508
DECIDE JUDGEMENT LEVEL OF DISTRIBUTED PROXIMITY SENSOR.
509
OBTAIN ENVIRONMENT SIGNAL 126a.
510
CALCULATE DIFFERENCE BETWEEN TWO ENVIRONMENT SIGNALS.
511
CALCULATE ENVIRONMENT INFORMATION.
512
DISPLAY GUIDANCE INFORMATION FOR DRIVER.
YES
513
WHETHER PROCESSING IS TO BE CONTINUED OR NOT ?
NO
END

FIG. 37

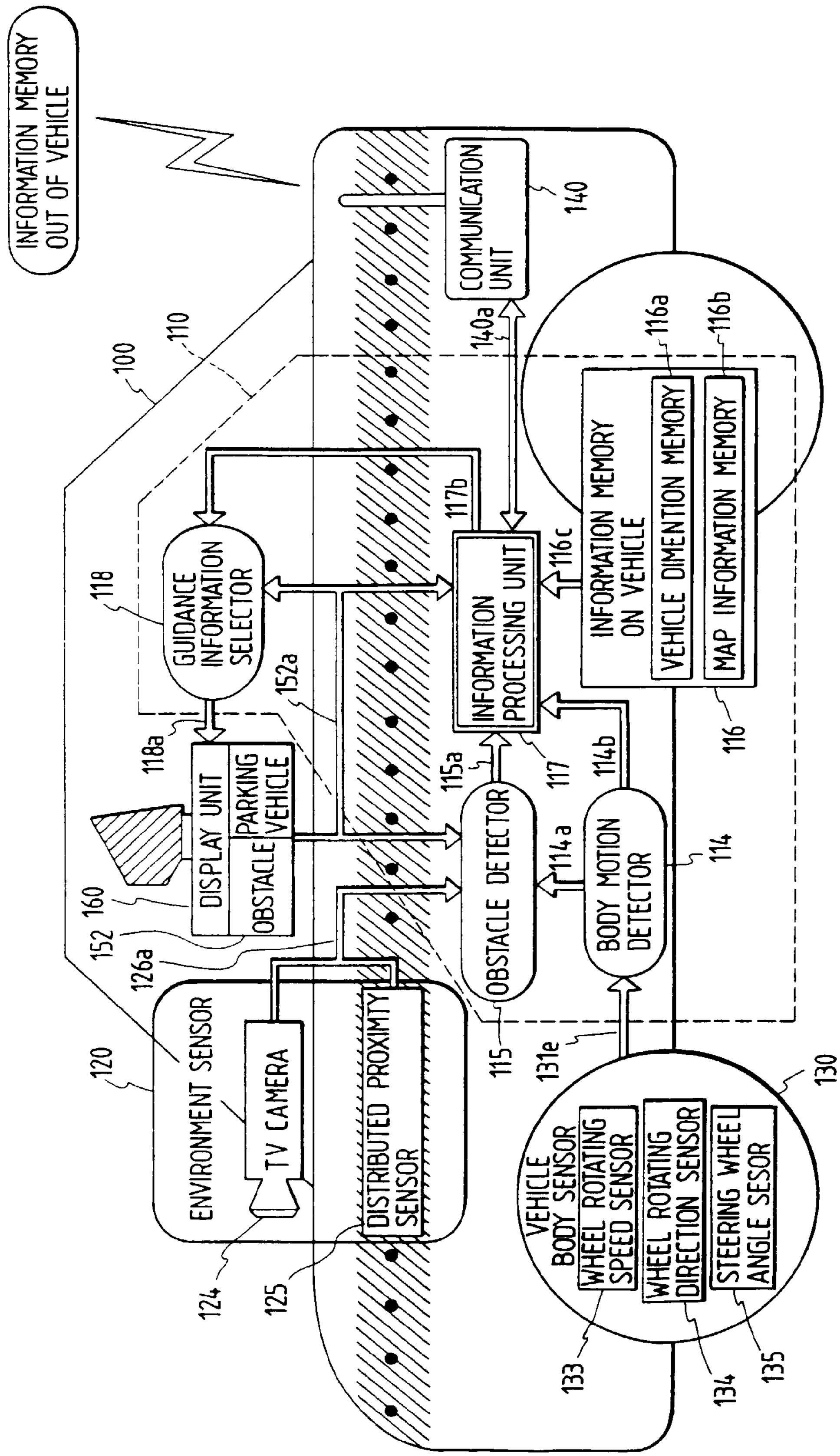

INFORMATION MEMORY OUT OF VEHICLE
100
110
COMMUNICATION UNIT
140
140a
116a
116b
INFORMATION MEMORY ON VEHICLE
VEHICLE DIMENTION MEMORY
MAP INFORMATION MEMORY
116
116c
117b
118
GUIDANCE INFORMATION SELECTOR
INFORMATION PROCESSING UNIT
117
152a
118a
DISPLAY UNIT
OBSTACLE
PARKING VEHICLE
160
152
126a
115a
114b
OBSTACLE DETECTOR
114a
BODY MOTION DETECTOR
114
115
131e
120
ENVIRONMENT SENSOR
TV CAMERA
DISTRIBUTED PROXIMTY SENSOR
124
125
130
VEHICLE BODY SENSOR
WHEEL ROTATING SPEED SENSOR
WHEEL ROTATING DIRECTION SENSOR
STEERING WHEEL ANGLE SESOR
133
134
135

FIG. 38

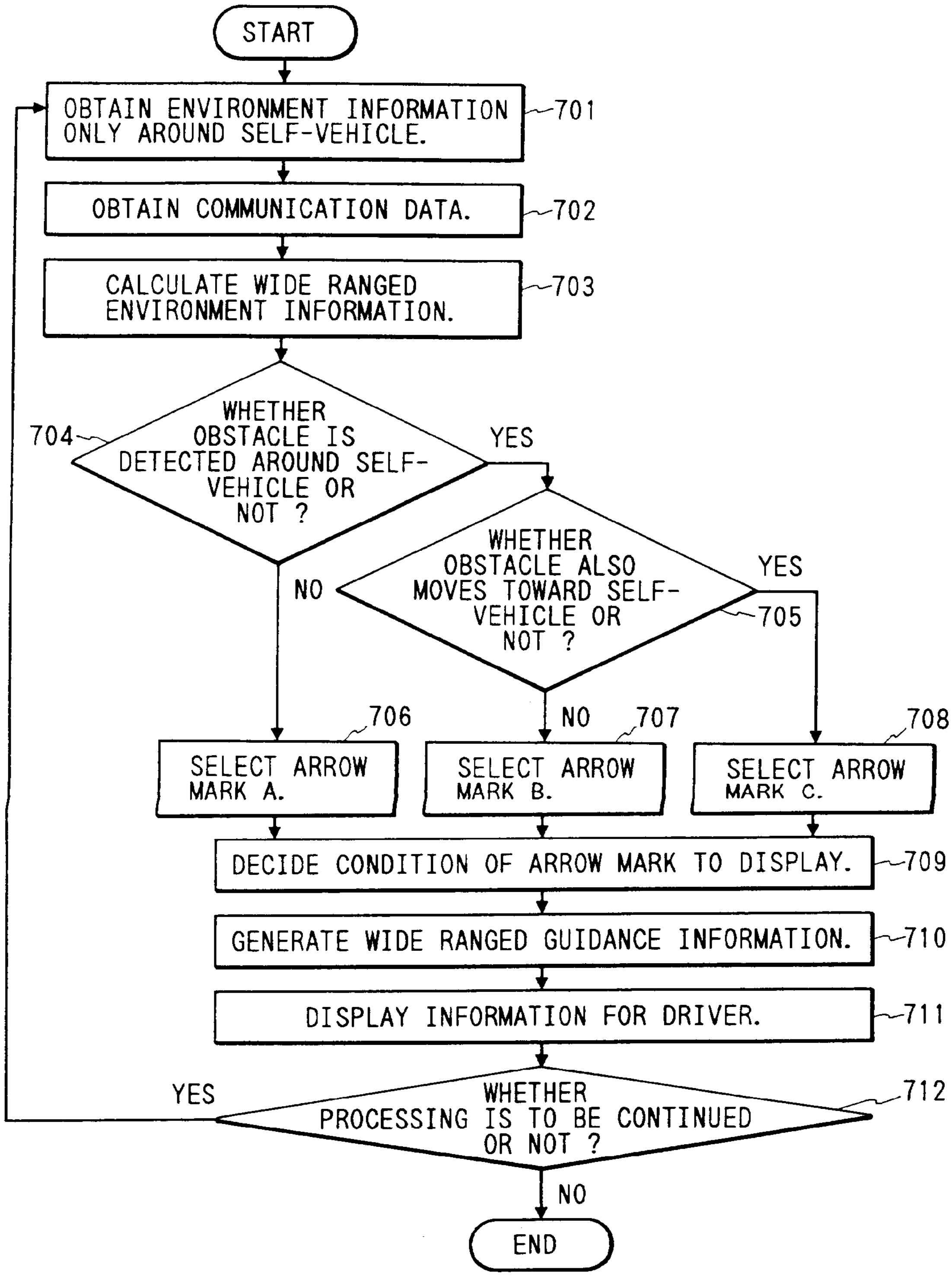

START
OBTAIN ENVIRONMENT INFORMATION ONLY AROUND SELF-VEHICLE.
701
OBTAIN COMMUNICATION DATA.
702
CALCULATE WIDE RANGED ENVIRONMENT INFORMATION.
703
704
WHETHER OBSTACLE IS DETECTED AROUND SELF-VEHICLE OR NOT ?
YES
NO
WHETHER OBSTACLE ALSO MOVES TOWARD SELF-VEHICLE OR NOT ?
YES
705
NO
706
SELECT ARROW MARK A.
707
SELECT ARROW MARK B.
708
SELECT ARROW MARK C.
DECIDE CONDITION OF ARROW MARK TO DISPLAY.
709
GENERATE WIDE RANGED GUIDANCE INFORMATION.
710
DISPLAY INFORMATION FOR DRIVER.
711
YES
WHETHER PROCESSING IS TO BE CONTINUED OR NOT ?
712
NO
END

FIG. 39

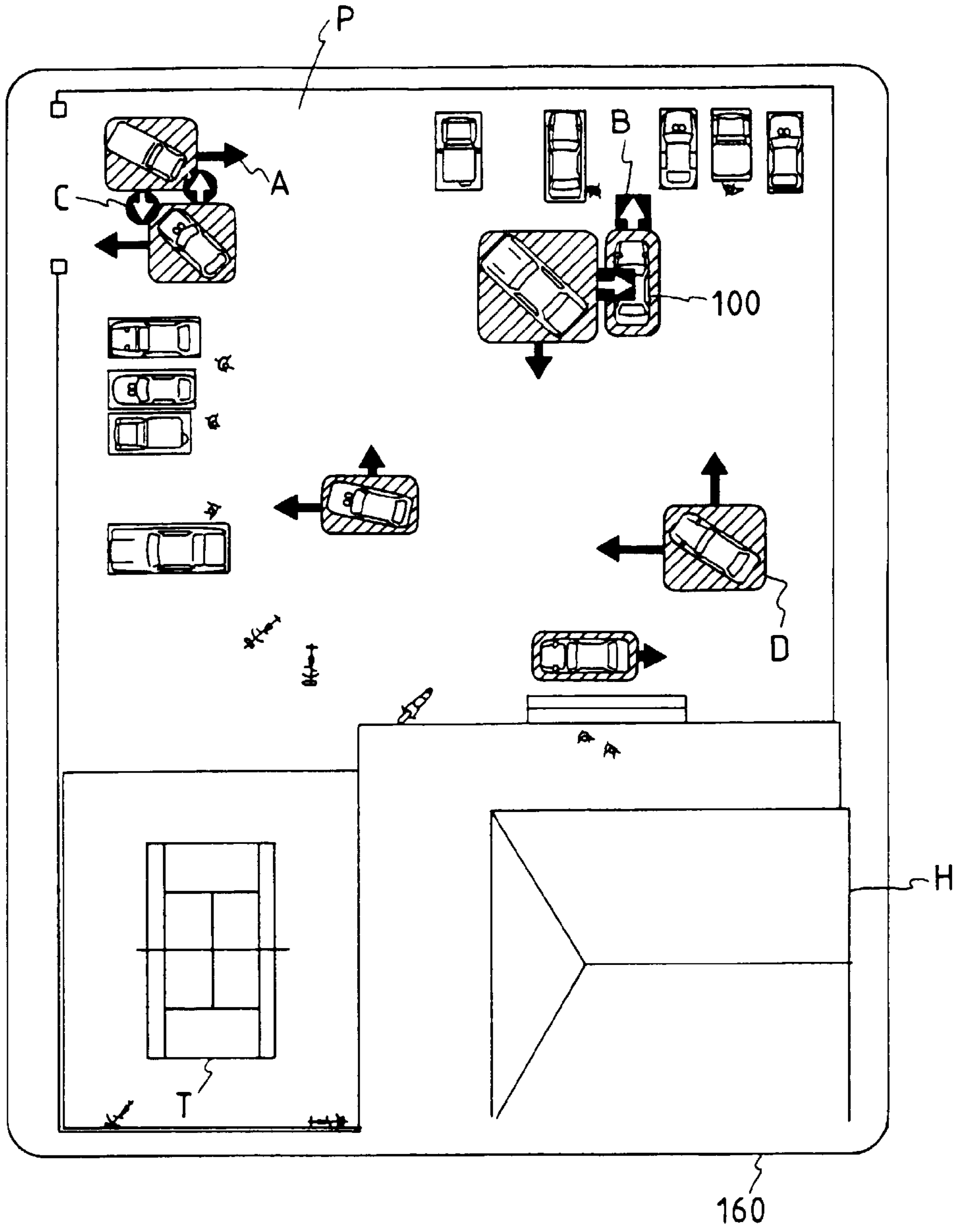


FIG. 40

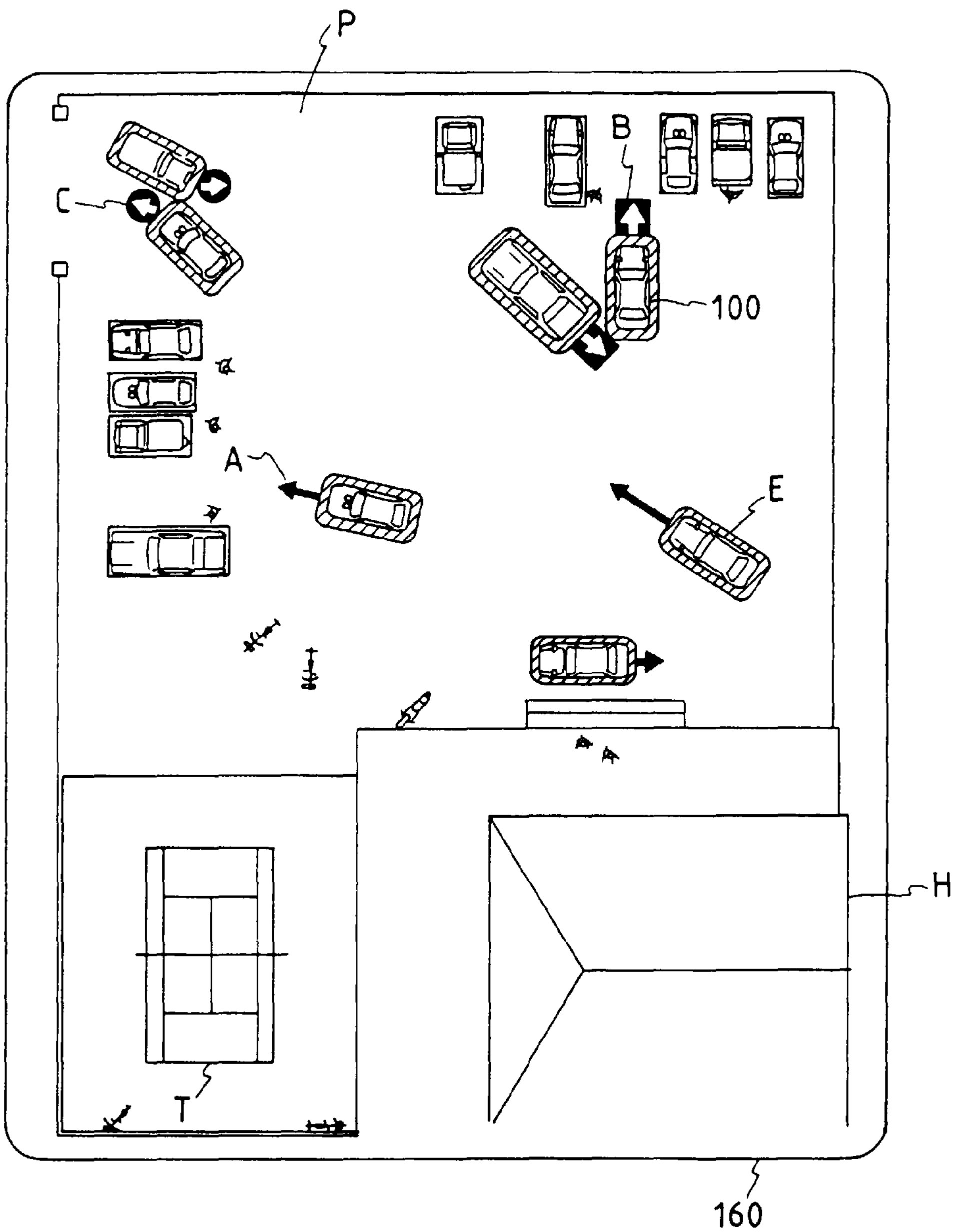


FIG. 41

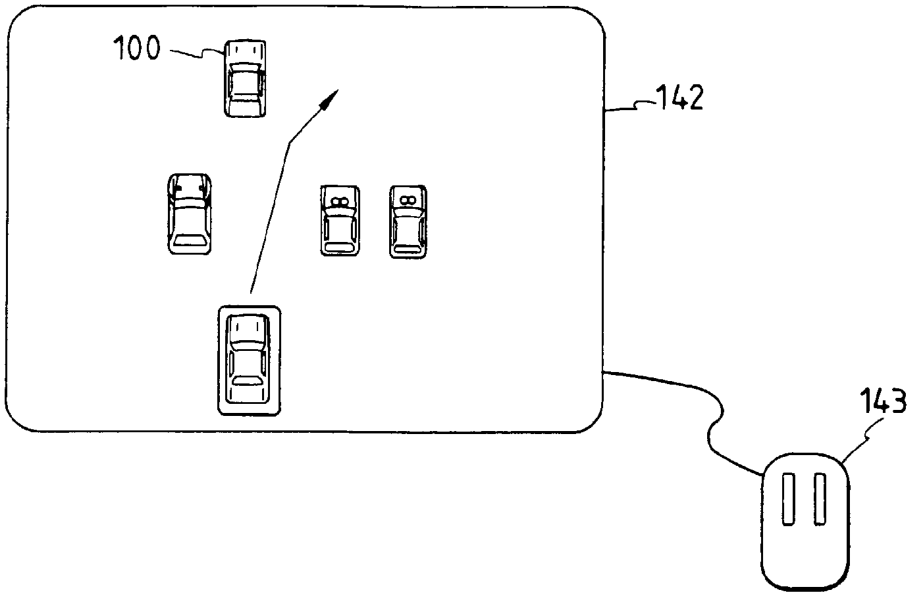



FIG. 42

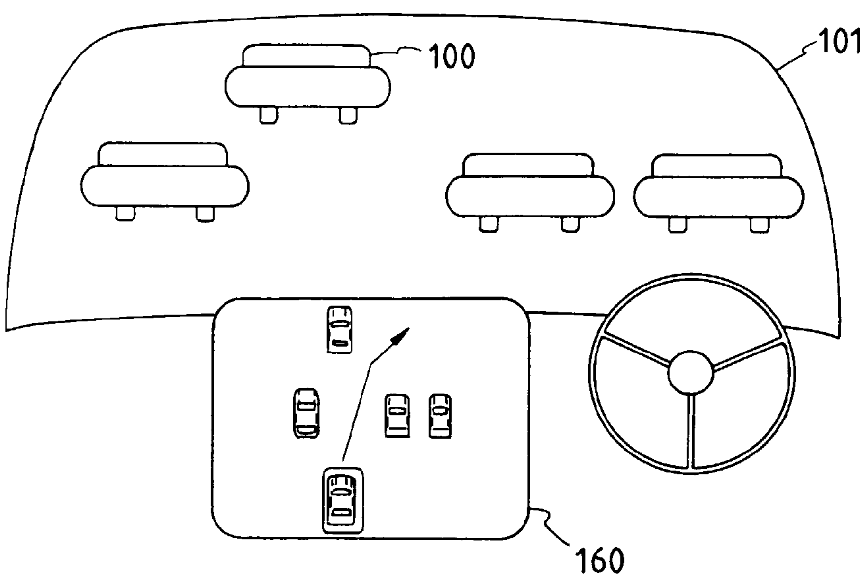
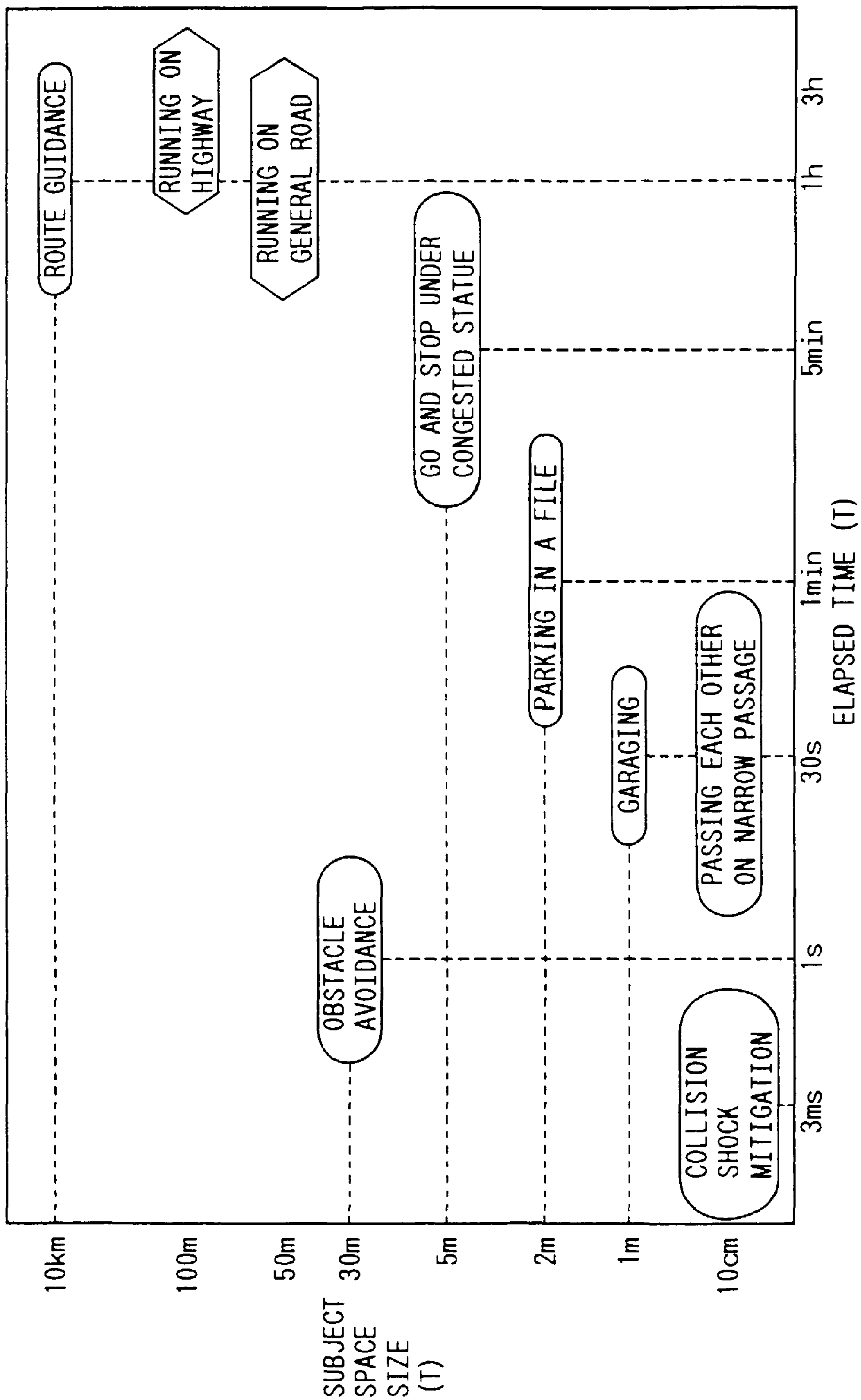


FIG. 43


ROUTE GUIDANCE
RUNNING ON HIGHWAY
RUNNING ON GENERAL ROAD
GO AND STOP UNDER CONGESTED STATUE
PARKING IN A FILE
GARAGING
PASSING EACH OTHER ON NARROW PASSAGE
OBSTACLE AVOIDANCE
COLLISION SHOCK MITIGATION
10km
100m
50m
30m
5m
2m
1m
10cm
SUBJECT SPACE SIZE (T)
3ms
1s
30s
1min
5min
1h
3h
ELAPSED TIME (T)